DESERTS

GAYLE PICKWELL

Jan 1946

Darling —
this is for us
and the day
we come back
here together
A—

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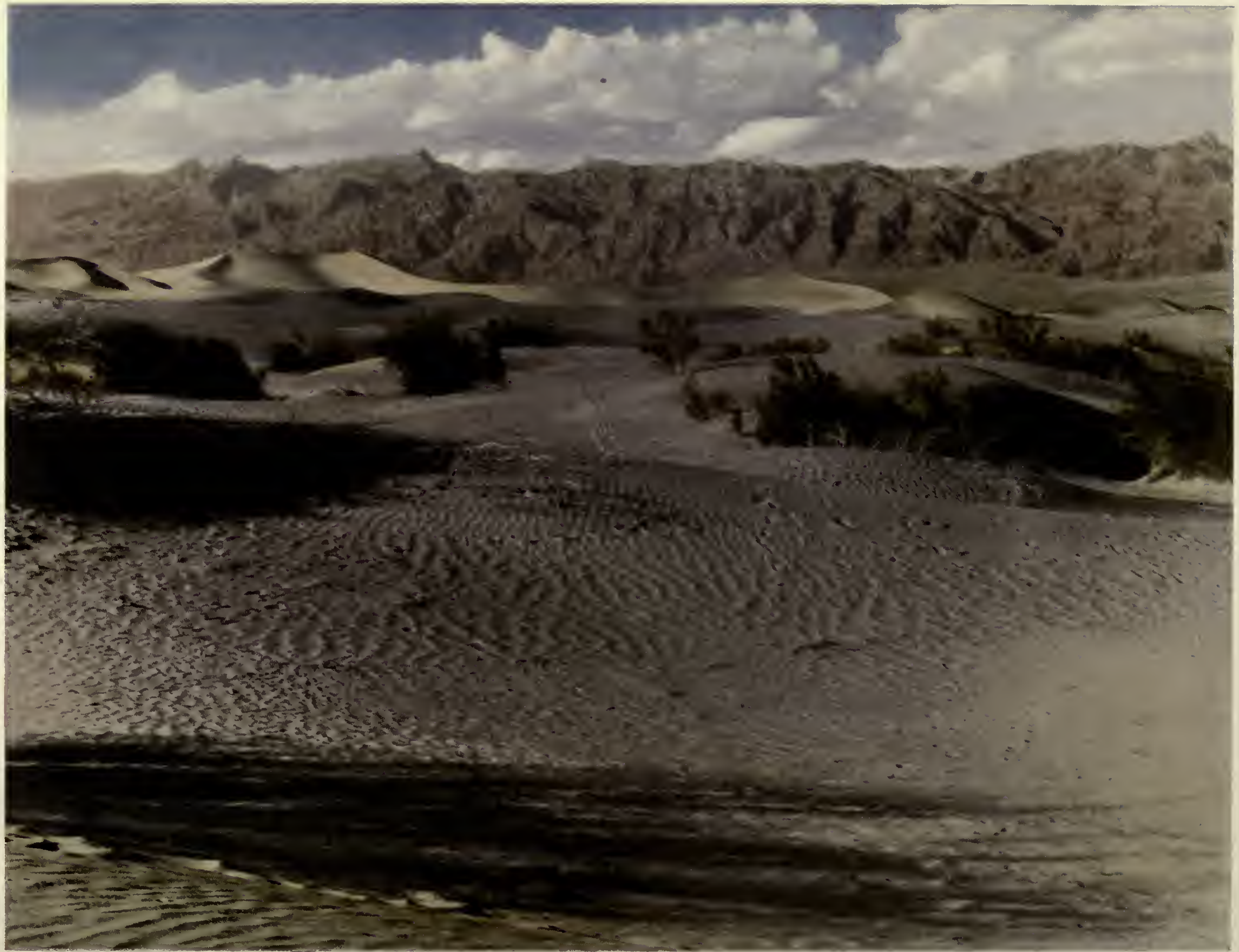
DESERTS

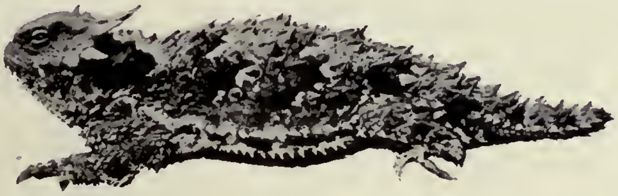


(*Frontispiece.*)

1. SAND DUNES IN DEATH VALLEY

DESERTS

BY GAYLE PICKWELL, Ph.D.



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PREFACE

Deserts serves as a general handbook to the true deserts of the United States, those that occur in California and Arizona, for it illustrates the conspicuous animals and plants that occupy them. It also describes "unsuspected deserts," areas in which surprising desert conditions may be found in the environment of everyone. It considers the locations of deserts, whether general or unsuspected, and illustrates the factors that make them. The book presents to the questing eye the problems of the xeric world, that world where water is scarce or at best unevenly supplied, a world altogether fascinating, in which, in spite of its dryness, many things have become adapted to live. Telling how they live is an important function of this book.

Deserts contains sixty-four full-page illustrations devoted to describing deserts, showing the mountains which cause them, the sand dunes, the desert pavement, and other conditions of the deserts; unsuspected deserts; and the life upon them. Among the illustrations of the plants of the true deserts there are photographs of those ephemeral blossoms, such as the Evening Primrose, which come forth following the infrequent rains, produce their seeds, and pass away in a few short days. There are illustrations of the "trees" and the "forests" of the deserts, such as the Joshua Tree, the Desert Ironwood, and the Palo Verde. There are photographs of those striking shrubs, the mesquite and Cat's-claw. In addition to the cactuses for which the deserts are most famed, there are illustrations of the animals, ranging from the Powder Post Beetle through the Centipede, Scorpion, Chuckwalla, and Sidewinder Rattlesnake to the Kangaroo Rat and Desert Antelope Ground Squirrel. With very few exceptions the photographs were taken in the desert. The animals were alive and active, often too active, when the pictures were made.

Several friends and students were companions on the numerous journeys into the deserts of the Southwest, and all assisted in the garnering of desert lore. One of the chief contributors was Emily Smith, who sat upon the sands and with her floral key discovered the botanical names of the plants the camera surveyed. Another was Tom Rodgers, whose skilled hands and keen eye in the use of the "lizard snatcher" kept us supplied with live specimens. Tom and Joyce Rodgers made the map of the deserts of the Southwest. Clarice Pickwell secured on the spot the proper colors which she gave to Illustration 1. Sincere thanks go to all these.

GAYLE PICKWELL.

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DESERTS

CHAPTER I

WHY KNOW DESERTS

TO KNOW HOW DESERT LIFE SOLVES THE DESERT PROBLEMS

Water where there is no water. For six weeks the Desert Antelope Ground Squirrel lived without a drop of water, yet it had water. The Big Desert Kangaroo Rat lived in the sand dunes of Death Valley. Springs and streams are notoriously absent from Death Valley, and the scanty green things last but a few weeks. Yet the Big Desert Kangaroo Rat found food, and with it, water. The grubs of the Powder Post Beetle were plump and juicy, but their only food was the dead, hard, and desert-dry Desert Ironwood, still they found water. All these used the water of metabolism. Their ability to do so is one of the secrets of desert life.

Safety in a big breath of air. The Chuckwalla drops into a crevice between two rocks or slips beneath a stone when danger threatens. It fills itself so full of air that it becomes wedged tightly in its retreat. It cannot be pulled forth, even though it is good eating for the Prairie Falcon, the Raven, or the Coyote. The Indians like it, too; they get it out by deflating it with a sharpened stick or wire.

Safety on the open sand. The Ocellated Sand Lizard is so remarkably equipped with a sand-pattern coloration that when it is quiet it disappears. It lives on sand dunes and on sand dunes only. It has feet with fringes like snowshoes for soft going, and it has a shovel-shaped head for fast digging. The Gridiron-tailed Lizard has a protective coloration that works beautifully in the thin shadow of a desert shrub. If its coloration doesn't work, it can run so fast that the eye can scarcely follow it.

To solve the problems of a leaf. Green coloring matter in a plant is necessary for plant food making. Sunlight is necessary for the green coloring matter to work. The best way to display the green coloring to the sun is with a leaf. But leaves expose much surface, and water evaporates from that surface. Water is at a premium in the desert. How to solve this problem? Some plants in the desert do it by having leaves for a short time only, when some water is present. Some desert plants keep their leaves through the seasons, but their leaves will be coated with gum, resin, or mealy scales to guard against the drying. The cactuses solve the problem best by having no leaves at all, but let their fleshy stems do all the work.

Blossom seasons are bridged by seeds. They stay in the sand unseen, these seeds, while the winds blow, and the sun boils down. The desert surface is starkly naked except for the scattered shrubs that brave the desert with stern plant fortitude. Winter comes, and rain. The hidden seeds germinate. They sprout forth. Very soon they bloom. For a few days the desert is aflame. And then the colors go. The stems wilt. Leaf rosettes wither and blow away. The desert winds blow, and the sun boils down. The desert surface is starkly naked except for the scattered shrubs that brave the desert with stern plant fortitude. But in the sands, unseen, there rests a new crop of seeds.

TO KNOW SOME OF THE THINGS THAT MAKE THE DESERTS

A desert is an answer to a mountain. Mount San Jacinto stands on the Colorado Desert's western margin. To its west is the great Pacific, scource of all the water of the clouds of that great region. The clouds roll up San Jacinto's western slope. They drop their rain. They make great forests grow. The clouds move on beyond San Jacinto, but they rain no more. At the mountain's eastern foot, some eleven thousand feet below its crest, are bare and rugged slopes. They have no trees. They get no rain. They are the desert.

Sand dunes are an answer to the desert wind. The wind blows up Death Valley. The wind blows down Death Valley. A gray cloud hangs through the center of the valley as the wind blows. It is the drifting sand. The sand might pile in the valley's north end when the wind blows to the north. It might be picked up again and piled in the valley's south end when the wind blows to the south. It does neither, for a spur of the Panamint Mountains, standing into Death Valley at Emigrant Pass, breaks the steady drift of air and swings it into eddies. From the eddies the sand is dropped and piled into dunes. The milder wind makes ripples on the dunes.

In the deserts, clouds may burst. Rain comes down in torrents at long intervals in the desert. The torrents roar down the naked mountains and are quickly lost in the lower sands. They bring much of the mountain down with them, though, and heap it in a fan of giant boulders at the mountain's base. Years may pass without a bursting cloud. There, on the gravel, between the boulders of the fan, the devil grows a garden. The garden is weird, grotesque, but beautiful. It grows on the land made by clouds that burst.

THERE MAY BE DESERTS NEAR AT HAND, QUITE UNSUSPECTED

Deserts are made by water, if it is salty. Pickle-weed grows in the marshes of the oceans. About its base the tides flow. Pickle-weed has scales for leaves. Pickle-weed has green and fleshy stems. Pickle-weed takes a lesson from the cactuses, for it lives in a desert. The ocean supplies Pickle-weed with water, but the water is salty.

Deserts are made by winter, if it is cold. Their leaves were so broad, so thin, so brightly green all through the season's warmth. Now they are gone. The trees are leafless. The frosts have come. The winter is near. Roots cannot take up water from soil that is very cold. Then, too, the water may be frozen. What would broad leaves, thin leaves, brightly green leaves do now? They have given the answer. They fall to meet the desert of winter's cold.

DESERTS HAVE NO WALLS TO MAR THEIR VIEW

The desert playa, that dry lake bottom, may be twenty miles away, yet the solemn march of dust devils over its powder-fine surface shows as clearly as if the old lake bottom were just across the road. There are purple-blue gorges in the desert mountains, and the desert mountains, too, seem near. That Joshua Tree, with supplicating arms, may be a lonely sentinel over great expanses, yet the eye denotes it though it may be miles away. In the deserts your greedy eyes may grasp a great domain within a single view, no walls obstruct.

CHAPTER II

WHAT IS A DESERT, AND WHERE ARE THE DESERTS

A DESERT DEFINED

A DESERT IS NOT A very definite thing. It can be defined only in general and in proportionate terms. It has, usually, less rain, more wind, more sun, and higher temperatures than other regions of the earth. At times, rain may fall in torrents on a desert, but it remains a desert still if the rain is erratically or unevenly distributed. Desert days and nights are often breathlessly still, but the wind may blow so hard at times that even the rocks are etched by the drifting sand or gravel. On the Mohave Desert in March, a blizzard may swirl snow wreaths about one's ears, but the daily weather maps of summer frequently warn "protect shipments against temperatures of 110 degrees Fahrenheit over the Mohave Desert."

Deserts are often regions of vast extremes, but all deserts share one thing in common: water is always their outstanding problem. Water there may be, but if it is salty or unevenly supplied, its use by living things is a problem, the problem of a desert. The Mohave, Colorado, and Sonoran Deserts receive yearly five inches or less of rain, and they are true deserts; but other regions are, in many ways, deserts, too, though much more rain may fall on them. This, however, is true of all: where water is difficult for living things to obtain, or long periods of drought prevail, there one will find the conditions of a desert.

THE WORLD'S DESERT ZONES

On a globe of the world, one may follow first a strip lying between 20 and 30 degrees south latitude. Start with Africa. The strip follows through the interesting desert regions of West Africa. The same strip passes through the center of Australia, the central and western portion of the great heart of which is vast desert. The strip strikes South America to include the northern half of Chile. Chile's coastal region here is desert. This desert region extends north to include, as well, most of the coastal region of Peru.

Though the desert regions south of the equator are large, those north of the equator are far more vast. The reason is simple: three-fourths of the world's land lies north of the equator. The desert strip north of the equator is modified by the great land masses and it fluctuates in position. It extends from 20 to 50 degrees north latitude. Start again with Africa and note the position of the Sahara Desert. Follow through to Arabia, almost all of which is desert. Swing beyond Arabia to Persia. Note the great Sandy Desert and many other deserts there. Just to the north of Persia lies the great Kara-kum Desert of Turkestan. Follow eastward until you reach the mighty Gobi Desert in Mongolia. Swing the globe to North America. Almost on a level with the deserts of the Old World lie the deserts of the New: the Mohave and Colorado Deserts of California, and the Sonoran Desert of Arizona and northern Mexico.

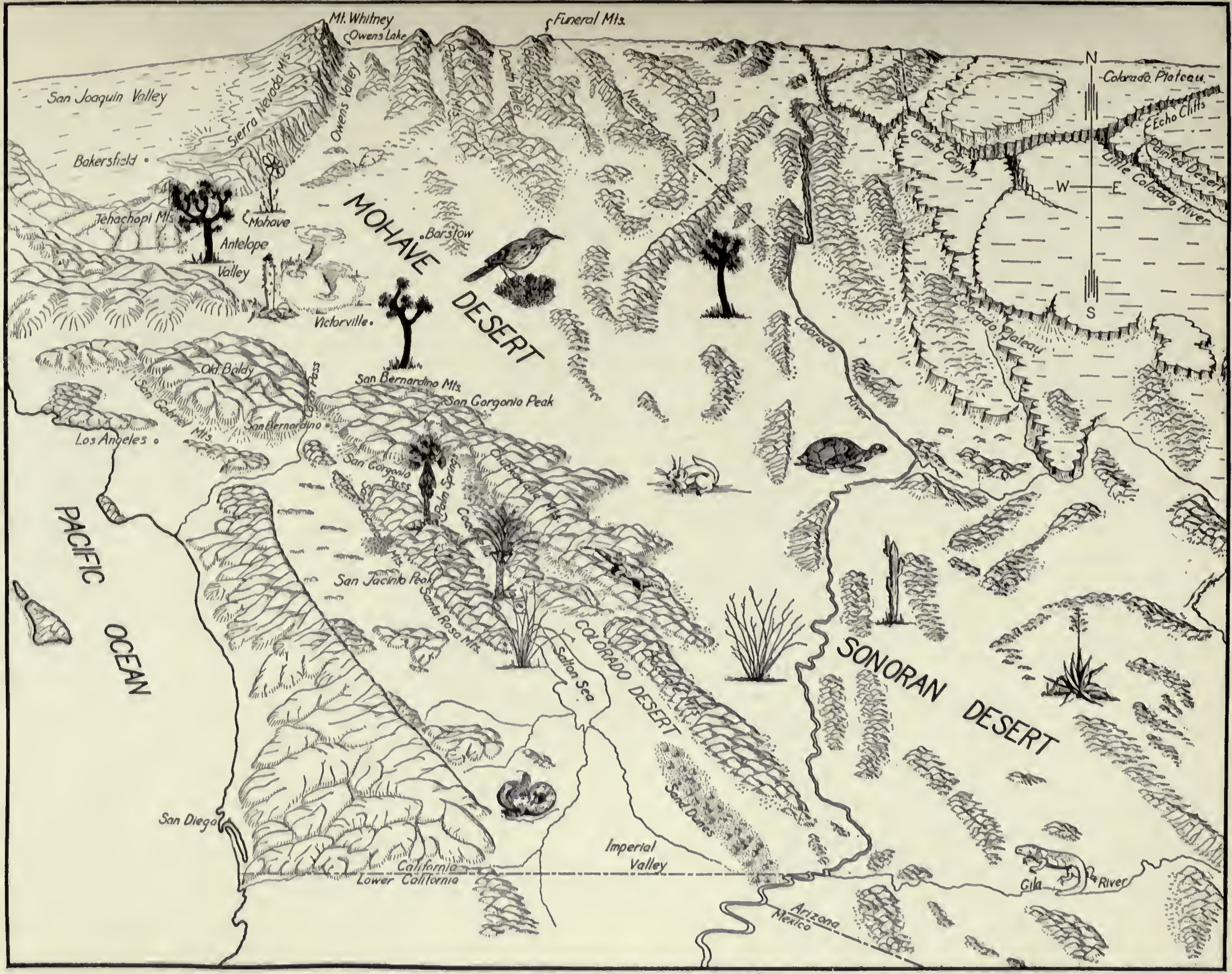
THE NORTH AMERICAN DESERTS

North America has regions as truly desert as any of those of the Old World. The driest of these lie in the true desert belt between 20 and 35 degrees north latitude, in northern Mexico and Southwestern United States. But the Cascade-Sierra Nevada Mountain chain captures much of the water of the air that swings inland from the great Pacific and this creates semideserts in eastern Washington and Oregon (the people there call these the "High Deserts"), and throughout Nevada, Utah, and western Colorado. This great sagebrush-covered region is known as the Great Basin. The fascinating Great Salt Desert of Utah is in this region, a region dried by the great mountains of the West (Illustration 5). Eastward of the Great Basin, the Rocky Mountain chain, rising high into the air again, captures rain anew. East of that, the air from the Gulf of Mexico brings new water for the Central Plains and Central United States. Here, though droughts prevail and dust storms blow, no true deserts lie.

Much of Texas lies in the desert belt, but the Gulf of Mexico, without mountains to interfere, waters some of it. As one moves away from the influence of the gulf, the presence of the desert belt becomes more and more pronounced, the regions drier and drier. Western Texas is dry, and New Mexico, were it not so mountainous and therefore high enough to secure some rain, would be pure desert. Desert it does have in the lower valleys that follow the rivers to the Rio Grande. Unmistakable deserts are reached in Arizona, especially on this state's western border. In this region, the northern tip of the Sonoran Desert reaches up from Mexico. Here is the home of that most positive indicator of the desert, the Creosote Bush (Illustration 28). The Colorado and Mohave Deserts continue this driest of regions beyond the Colorado River to make the deserts of California (Illustration 2).

The great Sierra Nevada Mountains at their southerly tip meet the Tehachapi Mountains. These mountains run to the west to meet the coast ranges. The Tehachapi's western edge swings south in the famous Ridge to meet the lofty San Gabriel Mountains. The San Gabriel Mountains run sharply to the east and south to meet, in their course, the San Bernardino Mountains. Just across the famous San Gorgonio Pass, in the middle course of the San Bernardinos, rise the San Jacinto Mountains. The San Jacinto Mountains continue south in the Santa Rosa Mountains toward the Mexican line. These mountains border the western fringe of the Mohave and Colorado Deserts. More important than this, they help to make the deserts!

The Mohave Desert is bounded on the northwest by the Tehachapi Range, on the southwest by the San Gabriel and the San Bernardino Mountains. The Tehachapi, San Gabriel, and San Bernardino Mountains form a long triangle with its apex to the west. This apex is the famous Antelope Valley. The triangle's base broadens as the desert extends toward the Colorado River, until this great desert at that point has a width of 250 miles. The south margin of the Mohave is rather definitely marked away from the Colorado Desert by the San Bernardino Mountains, which continue east as the Little San Bernardinos to a point within sixty miles of the Colorado River. Between the last of the Little San Bernardinos and this river there protrude a series of little mountain chains running mostly north and south. The Colorado River, as it separates



2. DESERTS OF THE SOUTHWEST

California and Arizona, forms a portion of the eastern margin of the Mohave, north to Needles, but the eastern margin of this desert north of this point runs without interruption into Nevada and across Nevada's tip into southern Utah and so becomes part of the Great Basin.

The northeastern portion of the Mohave is, perhaps, of the greatest interest, for here it extends its long arms between the ranges of great mountains that lie, north and south, in long ridges to the east of the great Sierra Nevada. One after the other these ranges rise: first the Inyo, then the Panamint, and lastly the Funeral, with valleys between successively drier and hotter. Between the Inyo and the Panamint is Panamint Valley; between the Panamint and the Funeral is famous Death Valley, lowest region in North America, hottest region in the world.

The Colorado Desert is a pygmy as compared with the Mohave, but it is equally famous and in many ways vastly different. Its north boundary consists of the San Bernardino Mountains, less definitely marked by little ranges between the San Bernardinos and the Colorado River. On the west, the desert reaches the towering San Jacintos that run north and south from a right-angled extension with the San Bernardinos and are separated from them by the San Gorgonio Pass. The San Jacintos continue south in the Santa Rosas and then in the ranges of the peninsula of Lower California. Most of the Colorado Desert is a large sink. This sink is occupied in part by Salton Sea, and extends north between the San Bernardino and San Jacinto Mountains as the Coachella Valley. To the south, this sink broadens into Imperial Valley. The conspicuous mountains within this desert are the Chocolate, that border the sink on the east and run in a long line southeasterly to the Colorado River.

UNSUSPECTED DESERTS

Though the great deserts of the Southwest supply most of the material for this book, there are some surprising exceptions. The conditions of a desert prevail wherever plants or animals experience difficulty in securing water. This may be at the foot of a mountain, the upper slopes of which have luxuriant forests. Trees shed their leaves in the fall to adjust to the desert that winter brings. Rains may fall profusely during the mild winter and spring in most of the Far West, but for four or five months during the summer there is not a drop. This presents a summer desert for the plants that grow there.

Sand in dunes, even beside a vast wetness such as a Great Lake or the oceans, dries quickly in the sun and presents a desert surface for the plants that would grow there. Plants that grow in soil with an excess of salt face a stern water problem, and so the surface of salt becomes a desert, whether it be the salt bed of the Great Salt Desert or merely alkaline barrens where improper drainage has allowed water to settle and to evaporate. A few plants can grow in a salt desert if it is also wet, but they have the form and structure of creatures of a desert. The mud flats of ocean estuaries, occasionally covered by the salty water of the tides, thus make another desert. In addition to those year-round and extensive deserts of the Southwest, these unsuspected deserts, for many the only near-by deserts, will receive some pictures and will occupy the first of the next chapter.

CHAPTER III

WHAT MAKES THE DESERTS

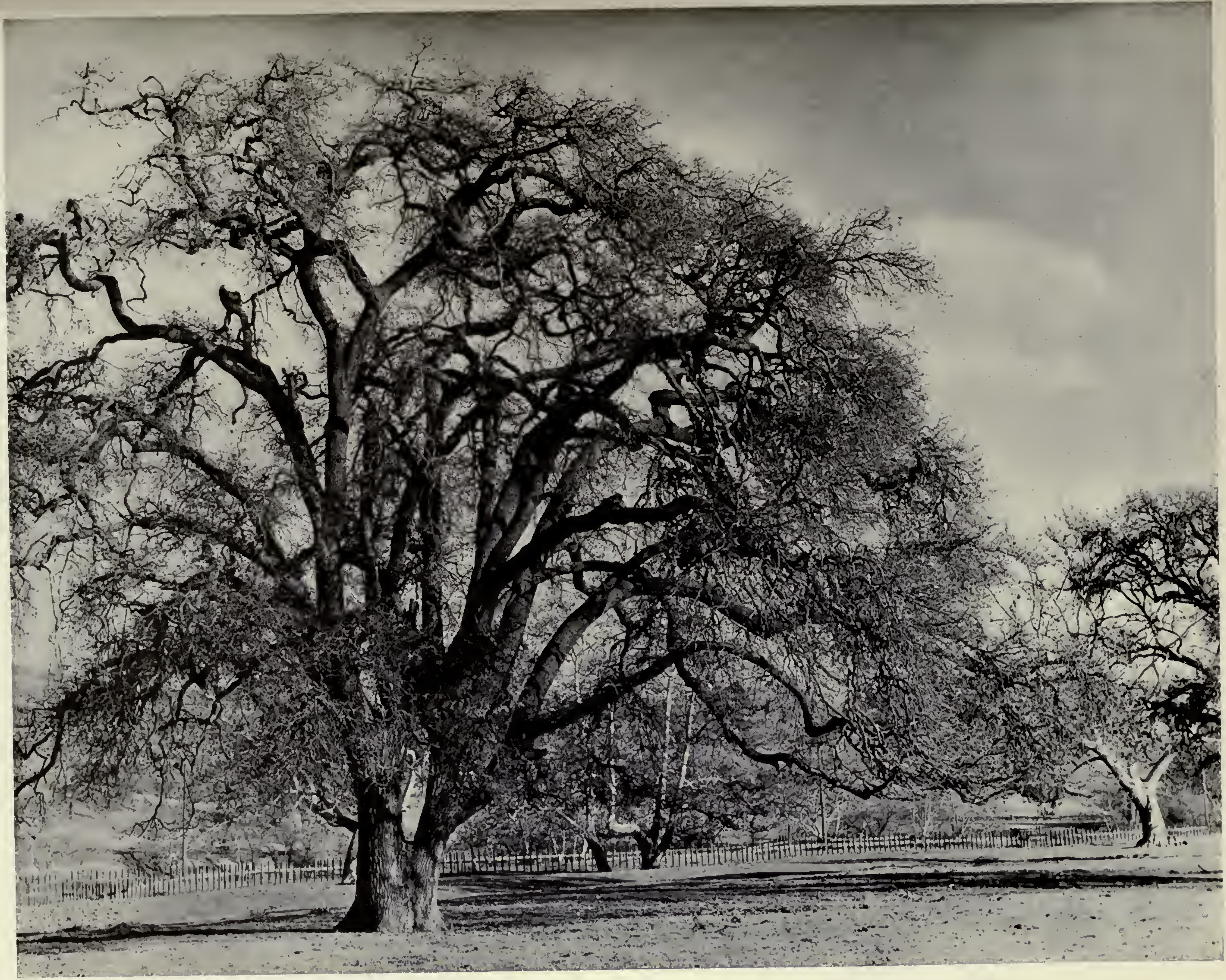
THE KINDS OF DESERTS AND THEIR REASONS

Deserts of the rain shadows. The eastern slopes of all the mountains of the West receive less rain than the western slopes. So much less that the slope exposure makes the difference between the heavy forests west of the Cascade Mountains and the juniper and sagebrush-covered plains to their east; makes the difference between the grassy and oak-covered foothills at the western base of the Sierra Nevada and the arid plains of Nevada that extend from the eastern base. Our nation lies in the westerlies; the storm areas moved by these persistent winds travel from west to east. The source of all water for the Western regions is the Pacific Ocean. This water vapor, carried eastward, descends in rain as it crosses the mountains —descends on the mountains' western slopes. The eastern slopes receive very little water; they lie in the rain shadows.

The colorful name "rain shadow" will apply to the eastern slopes of all Western mountains. The rain shadows make the "high desert" of sagebrush and juniper in eastern Washington and eastern Oregon; and as one moves south and enters the desert zone, the rain shadows become progressively drier until the great Southwestern deserts are reached. Here, to the rain shadow, is added the dryness of the desert zone.

Coast range mountains fringe the western side of the great Sacramento-San Joaquin Valley in California and they make a rain shadow that runs the full length of this valley's western side. The rain shadow of the Sierra Nevada reaches out to make a near-desert of all Nevada, Utah, and western Colorado. Even on the eastern slopes of the Rocky Mountains in Colorado the shadow again is felt, but here it rapidly becomes dimmed as one progresses toward the east, for the Gulf of Mexico furnishes a new source of water for the great interior. The Atlantic Ocean brings moisture into the cyclonic areas as they cross the Appalachian highlands and so prevents a rain shadow there. But throughout the West, the unsuspected deserts of the shadows of the rain stretch eastward from the feet of all the mountains.

Deserts of the winter's cold. In regions where the winter temperatures descend to freezing or below, a desert condition is presented for all the plant life. A desert prevails if the temperature falls below freezing even though the ground is saturated with water, for plants cannot transport water at low temperatures. Annual herbs, those plants of but a few days or months which wilt away under the cold to live through the winter as seeds or rootstocks or bulbs, are making an adjustment to desert conditions. Herb annuals or deciduous herb perennials owe their develop-



3. LEAFLESS VALLEY OAK PREPARED TO MEET THE DESERT CONDITIONS OF WINTER

ment to the desert of winter. The annual herb condition is not a necessity in the tropics.

Deciduous trees shed their leaves to meet the winter desert, and so a naked stem is a desert emblem (Illustration 3). Conifers—the pines, the firs, the spruces, the cedars, the hemlocks—are evergreen because their needlelike leaves are covered with a heavy varnish to resist the drought conditions of the winter. Where winters are very cold, the conifers will be the only evergreen trees, but in the Far West or South, where winters are milder, there are many other evergreens. They all have, however, the varnished leaf or the thickened leaf that the desert demands. In this respect they are like the evergreen plants of the true desert.

Deserts of the summer's dry. Most of the lowlands of California present a condition that is just the reverse of the winter-cold deserts of other regions or of the Far Western high mountains. During the lowland winter a great activity goes forward in the plant world and in much of the animal world, too, for rains fall and the temperatures are high enough. Plant life is lush in the lowland winter. When summer comes there comes also a desert, for rains no longer fall. Now the hills are brown, the grasses and all the succulent herbs wilt away. The lowland Buckeye, which spreads a full foliage in February, loses all its leaves when July comes. It reverses completely the behavior of trees in winter-cold deserts, for it lives in a summer-dry desert.

On the summer-dry hills, a desert assemblage replaces the lush and verdant plants of winter. Tarweeds, protected against drying by their gummy covering, scent the air. Turkey Mullein and many another plant show leaves gray-woolly, hairy, or prickly to the blazing sun.

The chaparral, too, that forest of elfin trees, is composed of elves because it lives in a summer-dry desert. The season of drought where the chaparral grows is mild in temperature and the elves, therefore, do not live in a fierce desert, but many modifications to meet a long season of desert trials are shown nonetheless. The gnarled and elfin stems of all, the thick leaves of the manzanitas turned edgewise to avoid some of the light, the tiny leaves of chamise, the leathery leaves of the scrub oaks, are all devices to cope with the summer-dry desert.

Rocky ridges, and slopes with southern exposure, have something of a desert, too. Here the Mexican Balsamea shows scarlet flower tubes and the California Sagebrush shows its fine gray leaves. From rock crevices the rosette of thick and fleshy leaves of some form of live-forever will peek forth. These all proclaim the unsuspected desert of the summer's dry.

Deserts of the lakes' and oceans' dunes. The beat of waves in many places along the Atlantic and Pacific Oceans, and strikingly at the south end and on the east shore of Lake Michigan, washes sand up onto the shore. This sand dries and is picked up by onshore winds and piled in dunes. The dunes become desert dry under the sun. With the lash of the wind they are constantly shifting. Plants living on them are modified for this desert world. That the dunes are deserts is attested by the fact that a large number of the plants are members of the same families and genera found in the true deserts. These dunes are thus another unsuspected desert.

The Yellow Sand Verbena (*Abronia latifolia*) (Illustration 4) is closely related to the verbena of the Colorado Desert (Illustration 18), but it lives beside an ocean of water, the great Pacific. This verbena of the ocean has leaves that are oval and thick for water storage. Its roots go deep, so it forms an anchor to hold the drifting sand and thus piles the sand into a little mound which it covers like a cap. On these same dunes grows the Shore Morning-glory, with fleshy leaves entirely unlike those of morning-glories of wetter regions. This is the home, too, of the remarkable Sea Fig (Illustration 21), which stores water in curious three-cornered leaves. Other plants of the Pacific's dunes are desertlike in that their leaves are thick and fleshy, or small and gray like those of the Bush Lupine, or finely divided. All this is in the desert mode.

These deserts of the lakes' or oceans' dunes provide a remarkable opportunity to compare the structures of desert plants with the structures of plants of our normal world. One may do this within a very short journey, for often these extremes grow almost side by side. Desert-loving plants—and this includes the plants of dunes—are called "xerophytes"; and the plants of regions where water may be normally supplied are known as "mesophytes." A collection of xerophytes, such as the plants of the dunes, may be taken to a near-by fresh-water stream or an adjacent woodland and placed beside a handful of the woodland mesophytes. The leaves from the woodland are broad, thin, smooth, and brightly green. They wilt quickly. The leaves of the xerophytes are thick or very fine. They are a somber green or gray. They may be covered with a coat of fine powder or wool. They are adjusted to the sun and dry. They do not wilt.

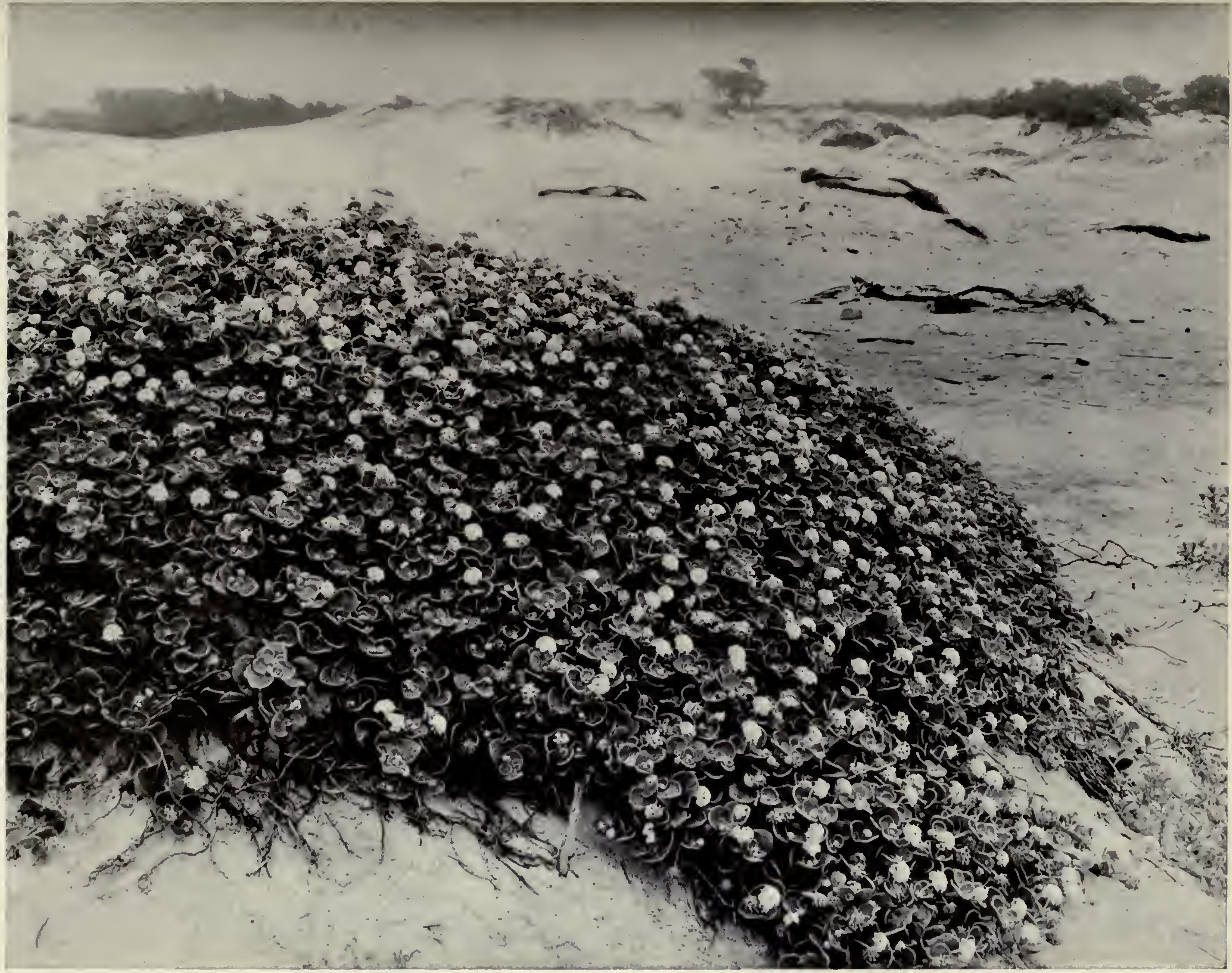
One may get the roots of the xerophytes, but only by digging deeply, for they send long taps in search of the water that drains to the depth of the sand. The roots of the mesophytes search shallowly; water for them is near the surface. Mesophytes live in our world, a world of provident water. The xerophytes live in the desert world, even though it be a dune and unsuspected; unsuspected because the source of all the water for the land is just beside it.

Deserts of the salt. Regions which do not have proper drainage develop a soil of great saltiness, since the water evaporates and leaves its minerals behind. These regions vary from deserts of sheer salt, such as the Great Salt Desert of Utah (Illustration 5), and many of the saline and dry lake beds, or "playas," of the northern Mohave and Nevada, to the alkaline barrens that occur so frequently through the rain shadow of the southern and western portions of the San Joaquin Valley. Water is usually not plentiful in such regions, and in deserts of salt the plants experience the additional difficulty of having to lift salty water through their tissues.

Much of the northern part of the state of Utah was covered long ago by a great lake known as Lake Bonneville. This great lake has dried down to the much smaller Great Salt Lake, and as it dried it left a glistening desert of salt. Much of this white expanse is without plant life, but in some places, especially along the western fringe, some plants do grow as shown in Illustration 5. Almost insurmountable problems confront plants that would secure water and the other chemicals needed for plant growth in regions of sheer salt. The plants of Illustration 5 have solved this latter problem by trapping the soil that blows in over the glistening deserts from the mountains of Nevada, and have built for themselves little mounds. The plants that live upon the playas of Nevada use a similar device and in places make dull-green caps for mounds three to six feet high —little islands in seas of salt.

Deserts of the wet. The desert of the wet is closely related to the desert of the salt. The only significant difference is that one may have much water and the other very little. Both these deserts are saline; the problems for their plants are similar. The problems for one, the desert of the salt, are just a little more stringent than those for the desert of the wet. The bays and sloughs that reach in from the oceans furnish the most extensive of the deserts of the wet, and on the muddy flats that the tides cover twice daily, or cover only now and then, a desert flora grows.

Though the waters of the ocean supply them, the plants are in a desert still, for ocean water is salty. Osmosis, the process by means of which plants secure water, will work to lift this water only if the sap of the plant is more viscid or under osmotic pressure higher than that of surrounding water. The requirements for osmosis are a porous membrane and liquids of greater density on one side than the other. When these conditions prevail, liquid passes through the membrane from the region of lesser density to the region of greater density. The roots of plants supply the porous membrane and so plants secure their water by osmosis from the soil. But if, as in the case



4. YELLOW SAND VERBENA IN THE DESERT OF THE PACIFIC OCEAN'S DUNES

with sea water or any other extremely salty water, the liquid outside the plant roots is as dense or more dense than the plant's sap, then osmosis will not work. Indeed, for a mesophytic plant, osmosis may work in reverse and drain water from the plant rather than supply it with more. Even in wet deserts, however, osmosis will work properly for a few plants.

One of the commonest on the mud flats of the Pacific Ocean is Alkali Heath (*Frankenia grandifolia*), which lifts and evaporates sea water to get the proper food materials, and has the surface of its leaves covered with salt crystals. It has tiny gray leaves like a true xerophyte, and it has arrived at the proper method of living in the desert of the wet. Another common member of the plant life of the wet desert is Pickle-weed (*Salicornia ambigua*—Illustration 6), which lives in the salt marshes of both coasts. Pickle-weed, in form and structure, is a child of a desert, a true xerophyte. Its thick and succulent stems are somewhat like those of a cactus, except that they are very salty. Its leaves are reduced to tiny scales. Thus it proves that, though the tides may ebb and flow about it, water is still its problem. Stems store the precious water and are green to care for the making of food. Leaves, which usually make the food, are reduced to scales, for they must not present a great surface from which water will evaporate, as with leaves of mesophyte plants.

At the fringe of the salt marshes, the point covered only by the occasional very high tide, a true barren occurs. Here the occasional salt water prevents the growth of all fresh-water plants, but even the salty water comes at such long intervals that Pickle-weed grows with difficulty. It is truly a no-man's-land, this fringe between the last of the desert of the wet and the world of normal plants. But it is home to a bird, the Horned Lark (Illustration 6). Horned Lark, child of the barrens, may be at home on the true deserts, on plowed fields, on ocean dunes, on bare hills, or in any place where plants are sparse. One of these homes is at the top of the ocean, wet now and then by the highest of tides. Here the nest may be in the cracked and salty mud under the shade of the Pickle-weed on the topmost fringe of a desert of the wet.

Year-round deserts. These are the regions that come to mind at the word "deserts." These year-round dry regions are the true deserts. They have the dryness of the horse latitudes, those regions of descending air that occur at about 35 degrees north latitude and 30 degrees south latitude between the trade winds and the westerlies. These regions in the United States have the dryness of rain shadows and the added dryness of high, sometimes unbelievably high, daytime temperatures during the summer. On the high deserts very cold weather occurs during the winter. These deserts are of several types: some portions are rocky, mountain wastes; some are great expanses of sand, made by agelong disintegration of mountain rocks; some are lake bottoms, which in drying have left dust-fine alluvial deposits, or various forms of salt. They all have five inches or less of yearly rainfall. They are our own deserts of the Southwest: the Colorado, the Mohave, and the Sonoran. Their characteristics will provide the discussion of the remainder of this chapter.

DESERT MOUNTAINS AND DESERT WINDS

The air of the horse latitudes descends, therefore it is clear. This clear air lost its water in ascents in other regions, therefore it is dry. The air becomes heated with the heat of compression as it falls, therefore it is warm to hot. Because of these conditions of the air of the horse latitudes, the deserts of the earth lie largely in their zones. The Mohave, Colorado, and Sonoran Deserts are deserts of the horse latitudes. If, in addition to the conditions of the horse latitudes, mountains lie between the deserts and the possible source of their meager rain, then the deserts are the drier. That is the situation with respect to the Southwestern deserts.

Most of the Mohave Desert is high in altitude, but the Colorado and Sonoran Deserts average low. Much of the Salton Sink of the Colorado Desert is below the level of the sea, and no portion of this desert reaches the elevation of the Mohave. It is, in general, due to this lower elevation that the Colorado Desert is warmer than the Mohave in winter and much hotter in summer. The official thermometer at Imperial frequently reports 117 degrees Fahrenheit, and temperatures much higher have been recorded.

The mountains within the deserts are of interest, but their contributions to the desert are incidental. The ranges that make the desert drier are those that border the western margins. These are the Sierra Nevada, the Tehachapi, the San Gabriel, the San Bernardino, and the San Jacinto (Illustration 9). They rob the deserts of their share of the rains from the sea, and add to the conditions of the horse latitudes to cause our Southwest deserts to join the ranks of the world's driest and hottest places.

The mountains exact from the deserts a heavy toll of water, and they contribute greatly to the desert's winds. During the day the desert heats under the rays of an unobstructed sun. The mountains, in the meantime, keep cool heads because their heads are so high. Before the sun has passed the noon, Nature busies herself in adjusting the differences in temperature between mountain crest and desert surface. The air comes soughing down from the summits to blow a gale at desert level. The town of Mohave, lying at the foot of the Tehachapi, experiences a daily wind that begins before noon and increases hourly in intensity until nearly midnight. Then it quiets, and ceases altogether before dawn. Desert temperatures have been adjusted.

During the late winter and early spring, the higher portions of the Mohave Desert are colder than the coastal areas. The wind then roars down from the elevations and through the passes, dry with the drought of the desert, drier still with the heat of compression, to spread over the coastal valleys in the dreaded Santa Anas. The Santa Anas parch the orange orchards and the gardens like a flame. Against these winds from the desert most orchardists place a windbreak of hardy trees, such as eucalyptus or cypress, on the north and east sides of their groves.

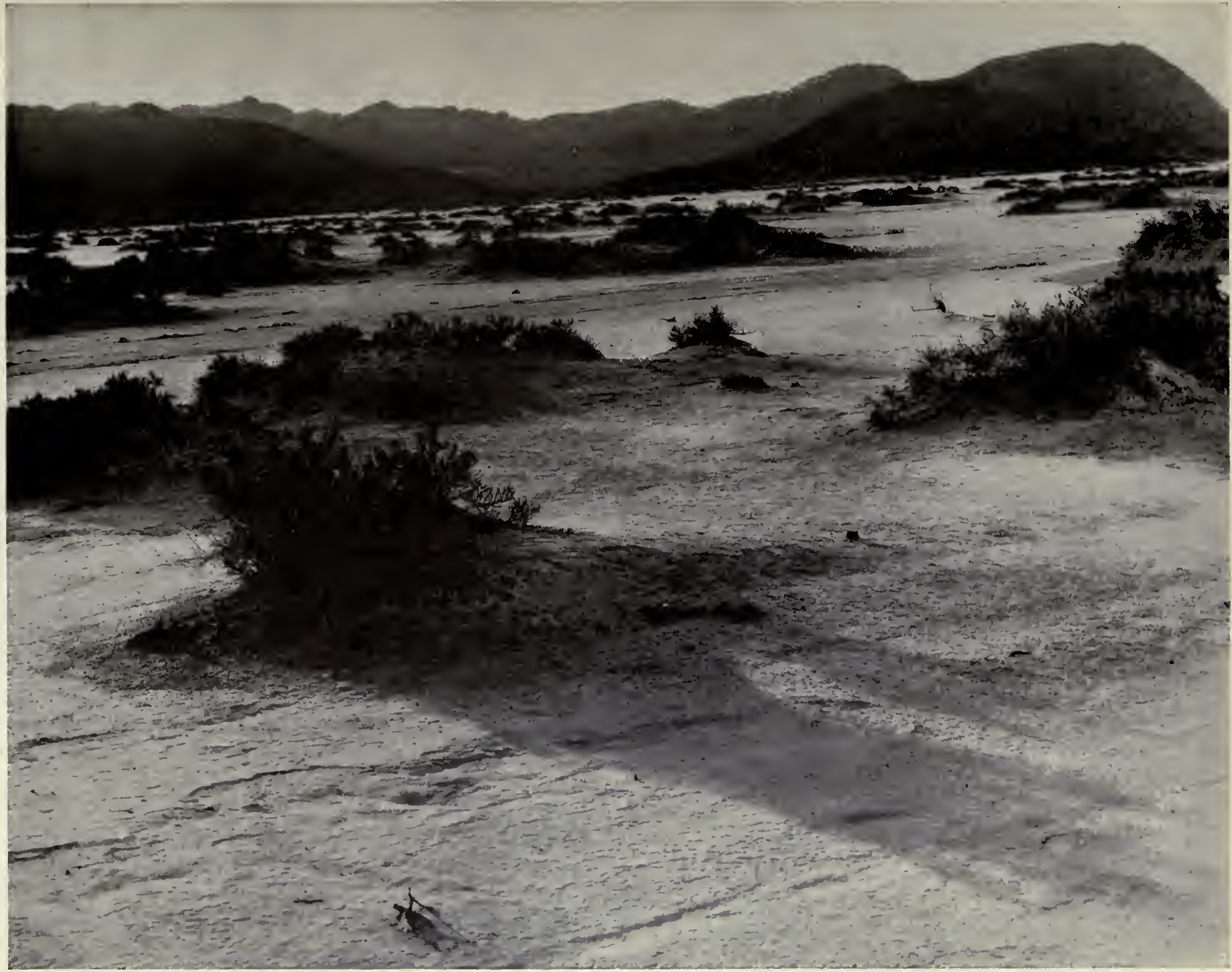
During most of the year the coastal areas are cooler than is the Colorado—at times much cooler. The cool coastal air then rushes into the Colorado through the San Gorgonio Pass to push up the heated desert air. During the afternoon and early evenings, the wind that roars through that pass into the Coachella Valley is so powerful that it is difficult to drive a car against it.

Desert winds do many other things: they drift sand, they modify much of the desert surface, they etch the rocks. The winds are creatures of the desert. The deserts are creatures of the zone in which they lie, and of the mountains on their borders.

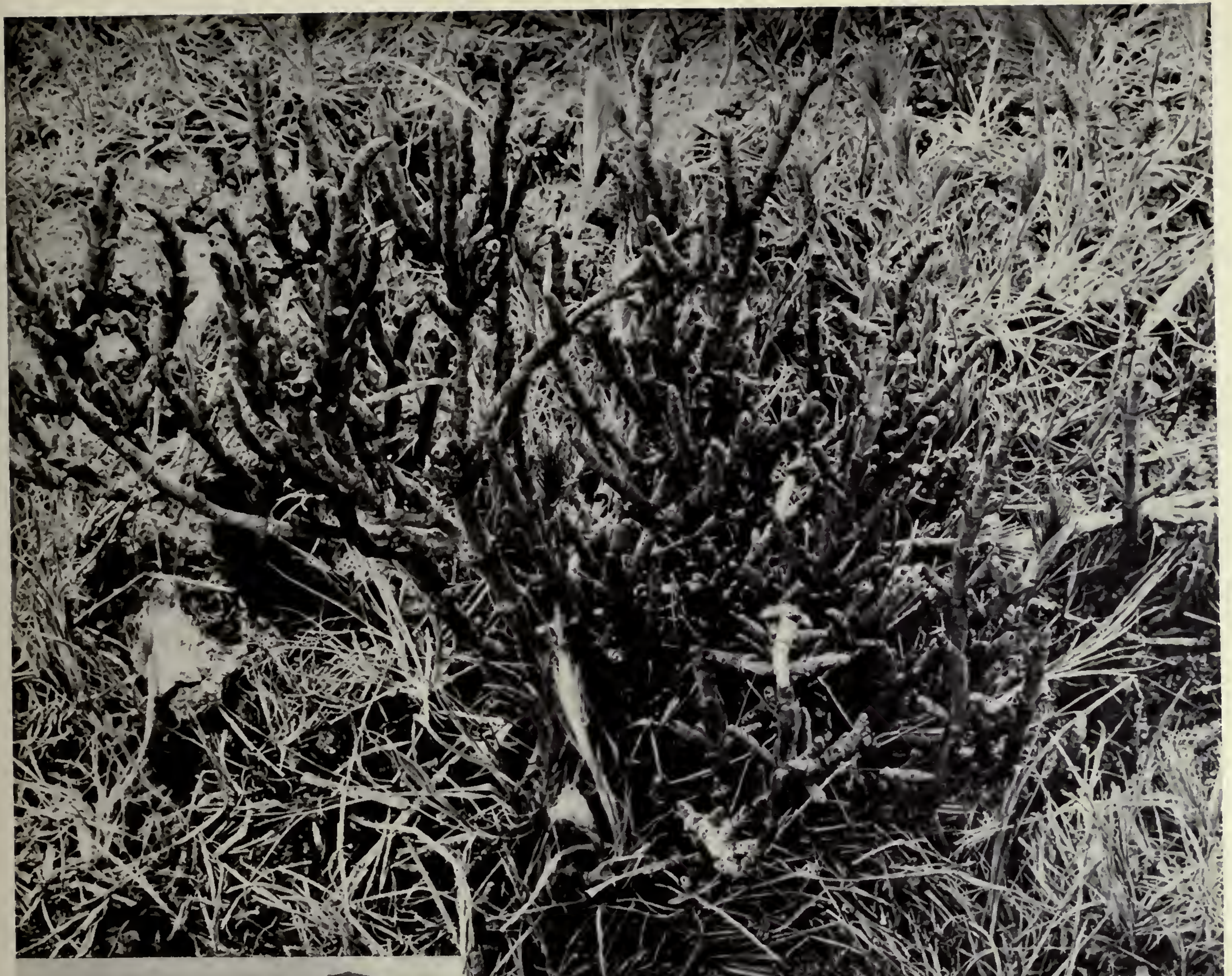
Some illustrations of desert mountains and the desert problems they present follow:

Joshua Trees and Desert Junipers in the Mohave below the San Gabriel Mountains (Illustration 7). The San Gabriel Mountains are a major reason for the extra dryness that makes the Mohave Desert. The mountains rise in places more than ten thousand feet above the sea; and since they stand to the south and west of the Mohave they are in line to capture most of the water that comes from the ocean. The ocean air in winter is moisture laden, but as it climbs the mountains it becomes chilled, chilled to a point where it can no longer hold all its moisture in invisible form, so clouds develop. From the clouds snow descends to make the snow-capped peaks. The air moves on down the desert side, but little moisture remains. The result is the Mohave, and on its upper edges where a little moisture falls will be found a weird forest of Joshua Trees (*Yucca brevifolia*) and Desert Juniper (*Juniperus californicus*).

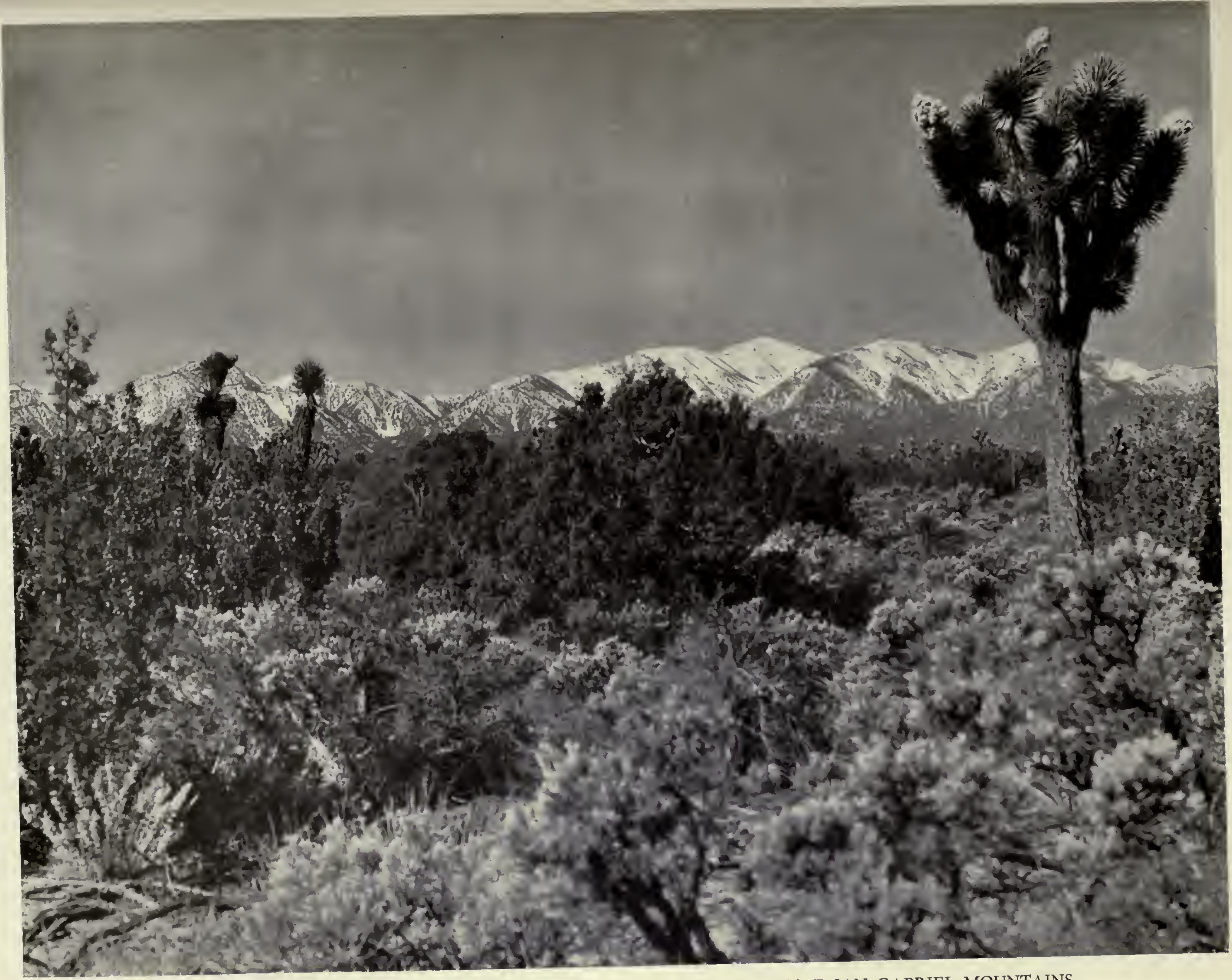
From the higher peaks of the San Gabriel Mountains, such as from the summit of Mount San Antonio, or Old Baldy, a persistent banner of clouds extends for thirty or forty miles over



5. THE WESTERN FRINGE OF THE GREAT SALT DESERT OF UTAH



6. HORNED LARK, LOVER OF BARRENS, AND ITS NEST BENEATH PICKLE-WEED ON THE MARGIN OF A WET DESERT



7. JOSHUA TREES AND DESERT JUNIPERS IN THE MOHAVE BELOW THE SAN GABRIEL MOUNTAINS

the Mohave before it is melted by the desert heat. The clouds are beautiful in themselves, but enhanced by the impressive majesty of the desert they leave one impoverished of words with which to describe them. Now and then the clouds mount the San Gabriel Mountains and still retain a large fragment of their potency. Now and then they leave puddles of rain upon the desert, and twice, in March, they have enveloped us in blizzards; once to leave three inches of snow. Blizzards in the desert!

Spanish Daggers bloom in deserts made by mountains like snow-capped Old Baldy (Illustration 8). The Spanish Daggers (*Yucca mohavensis*) were blooming, in March, in the famous San Gorgonio Pass, the pass that lies between the lofty San Bernardino Mountains on the north and the equally lofty San Jacinto Mountains on the south. This is the pass that leads, without any appreciable change of elevation, from orange blossoms and hayfields to deserts. In the short space of a few miles one passes from the mild world of orchards to the stark world of deserts, through a narrow cleft where the great mountains have separated a trifle to show their desert handiwork.

The winds from the Pacific deposit their last moisture to make snow-capped Old Baldy of the San Gabriel Mountains on the north, and then they roar down, hot and dry, over the Mohave. On the south, just a few miles away, San Jacinto and its neighbor mountains take their toll, and from them the winds blow down into the Coachella Valley, the long arm of the Colorado. Little moisture is left for the San Gorgonio and its Spanish Daggers. The pass must be content with hardy but beautiful plants; plants, the stiff stems of which can resist the fierce draft of air that blows like a hurricane from the cool sea into the hot desert.

One night a camp was made on the desert just a few miles from where these Spanish Daggers bloomed. We snuggled up on the sand behind a wall of rock and thought the wind would soon die down. But it blew and blew; all night it blew. It filled our hair with sand. It filled our ears with sand. It made little mounds of sand in the wrinkles on the lee of the sleeping bags. When the desert sun burst over the horizon, the wind was still blowing. Like a madcap bent on one last prank, it picked a pillow from a bed and rolled it a hundred yards along the sand.

A fragment of the Desert of the Colorado, made by snow-capped San Jacinto and its neighbor mountains (Illustration 9). The Colorado Desert begins in the narrow arm, called the Coachella Valley, that extends north and west between the San Jacinto and San Bernardino Mountains, to end in San Gorgonio Pass (Illustration 2). The Coachella Valley widens into the famous Salton Sink and then spreads out into the broad area of the Imperial Valley. Unlike the enormous Mohave Desert, which is not only vast but mostly two thousand or more feet high, the Colorado Desert is comparatively small, with much of it at or below the level of the sea.

As in all deserts, the lack of rain and the high temperatures of the Colorado are due, first, to its position in the horse latitudes and then to winds and mountains, except that in the Colorado these conditions are accentuated by especially high mountains on the borders and a very low area beyond them. Ocean air climbs the great San Jacinto Range and deposits copious moisture there, but the air that descends to the low desert is dry, very dry. The air is hot, too, for it gains heat as it loses its water, and it gains still more heat as it is compressed in its downward journey. Yet this combination of conditions, plus the water of the Colorado River for irrigation, makes possible the great winter garden of the Imperial Valley of this desert.

You are looking, in Illustration 9, from a region in the Coachella Valley that is just at sea level. The top of snow-capped San Jacinto towers more than eleven thousand feet above. Over two miles above desert sands and heat stands San Jacinto's cold and icy dome. The desert is largely the product of the mountain, and the mountain now stands guard above its child like a white-plumed major-domo.

Below the level of the ocean in the Desert of the Colorado, at the north end of Salton Sea (Illustration 10). Studies of American deserts are not complete without the story of Salton Sea. Briefly, it is as follows: Imperial Valley, the present region of Salton Sea, and much of the Coachella Valley were in past ages a part of the Gulf of California, and hence below the level of the sea. This area was anciently cut off from the gulf, either by an elevation of the land at the lower end or by the building of a dike by the deposit of the silt of the muddy waters of the Colorado River. The muddy Colorado worked back and forth across its delta, now flowed into the gulf, now flowed into the newly isolated sea. During the periods when the Colorado flowed into the gulf, the Salton Sea dried down to a salty bed. This way and that the river flowed: now there was a dry sink; again there was a sea. As recently as 1891 the Colorado flowed naturally into Salton Sea. Old beach benches about Salton Sea write its variable history of periods of drying and periods of high water.

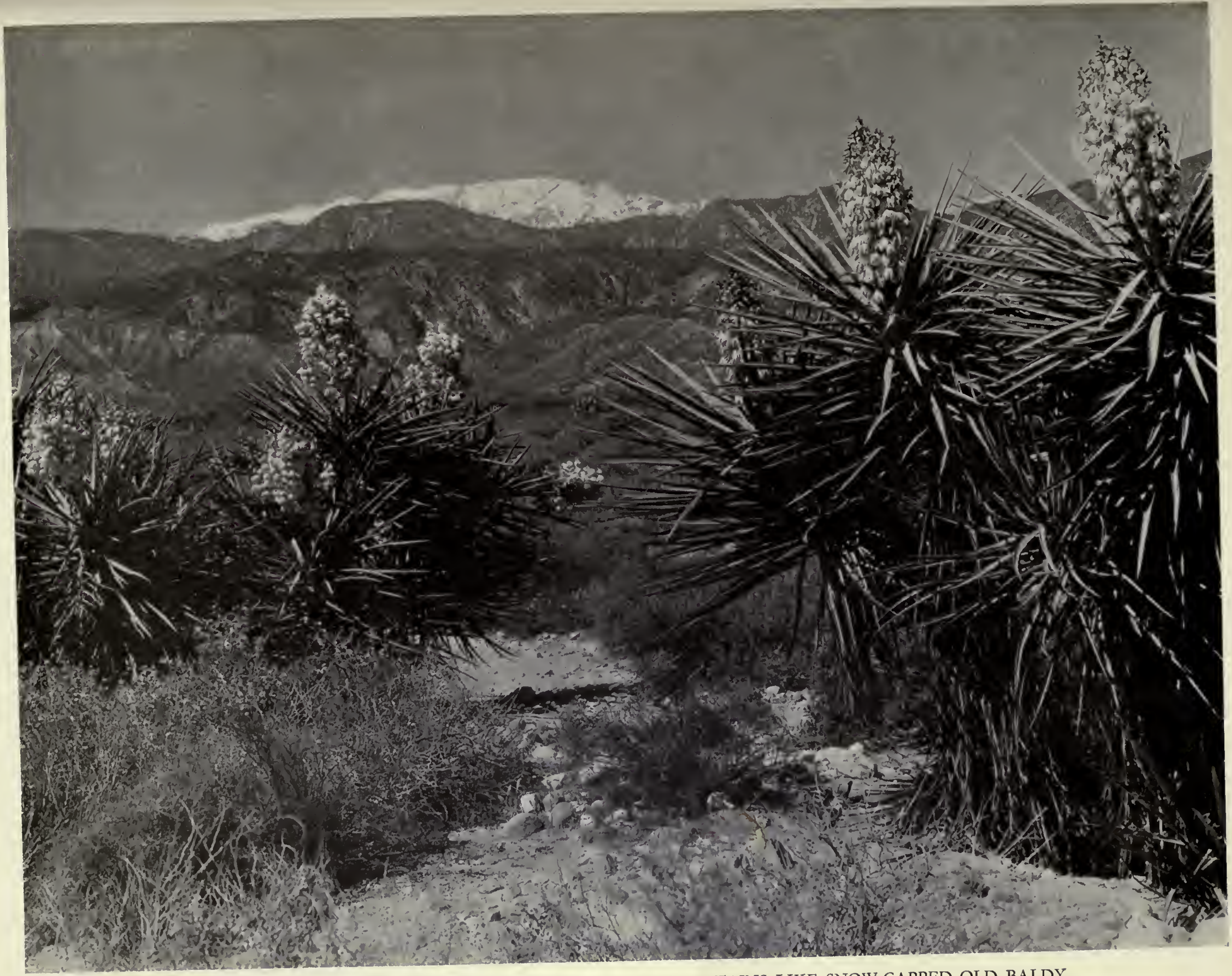
Between 1891 and 1905 no water flowed from the Colorado River into the Salton basin and it dried down to a sink with great areas of crystalline salt, salt that was mined for commercial uses. In 1905 the Colorado raged in flood. It scoured out the entry of the gate at the head of the Imperial Ditch, through which Imperial Valley received its water for irrigation. Down the ditch, and through neighboring "dry washes," the water flowed to the dry Salton Sink. Not until February, 1907, was the damage finally repaired and the flow stopped. At that time a new sea had been formed, more than four hundred square miles in area and nearly seventy feet deep. Since then the desert air is again in the process of drying Salton Sea back to Salton Sink. Many of us will live to see the day when a new Salton Sink, with dried silt and salt, more than two hundred feet below the level of the ocean, will mark the work of the desert.

Sand dunes in Death Valley (Illustration 1). A discussion of desert mountains and desert winds will be most forcibly illustrated by the conditions of Death Valley. Death Valley is really a part of the Mohave Desert, but it owes its existence to conditions somewhat different from those which produce the bulk of that great desert.

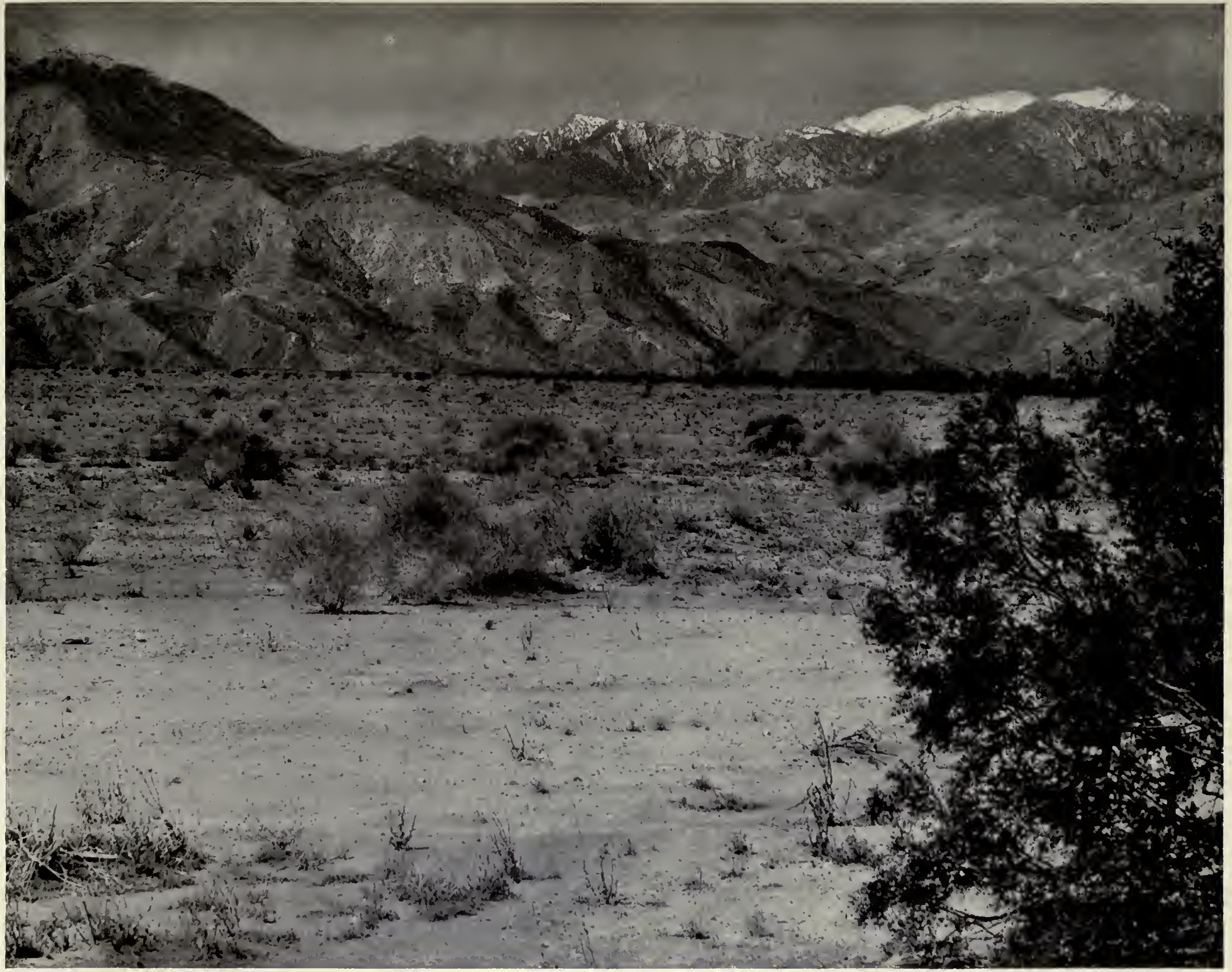
On the northern end of the Mohave three valleys stretch themselves north like fingers (Illustration 2). The Sierra Nevada borders Owens Valley on the west. On the eastern fringe of Owens Valley there is a series of ranges including the Inyo, the Slate, and a rather shallow one, the Argus, which forms the western border of the next valley, the Panamint. Panamint Valley is bounded on its east by the Panamint Mountains, and at the eastern foot of the Panamints lies Death Valley.

The air from the Pacific thus mounts first the mighty Sierra Nevada, which in this region includes Mount Whitney, tallest mountain in the United States, and on these tall peaks leaves most of its moisture. As a consequence, Owens Valley at the eastern foot of the Sierra Nevada is a desert, like its mother Mohave. The little range that rises to form the eastern fringe of Owens Valley can exact no further water from the skies, so it is desert like the Panamint Valley at its eastern base. The Panamint Mountains, however, with Telescope Peak rising more than eleven thousand feet, do capture a little moisture, enough to mantle their tops in snow during the winter (Illustration 13). But almost nothing remains for Death Valley at the eastern foot of the Panamints, and the merest trace for the Funeral, the Grapevine, or the Black Mountains that form Death Valley's eastern wall. For after a succession of rain shadows, Death Valley stands at the end of the series, driest of all.

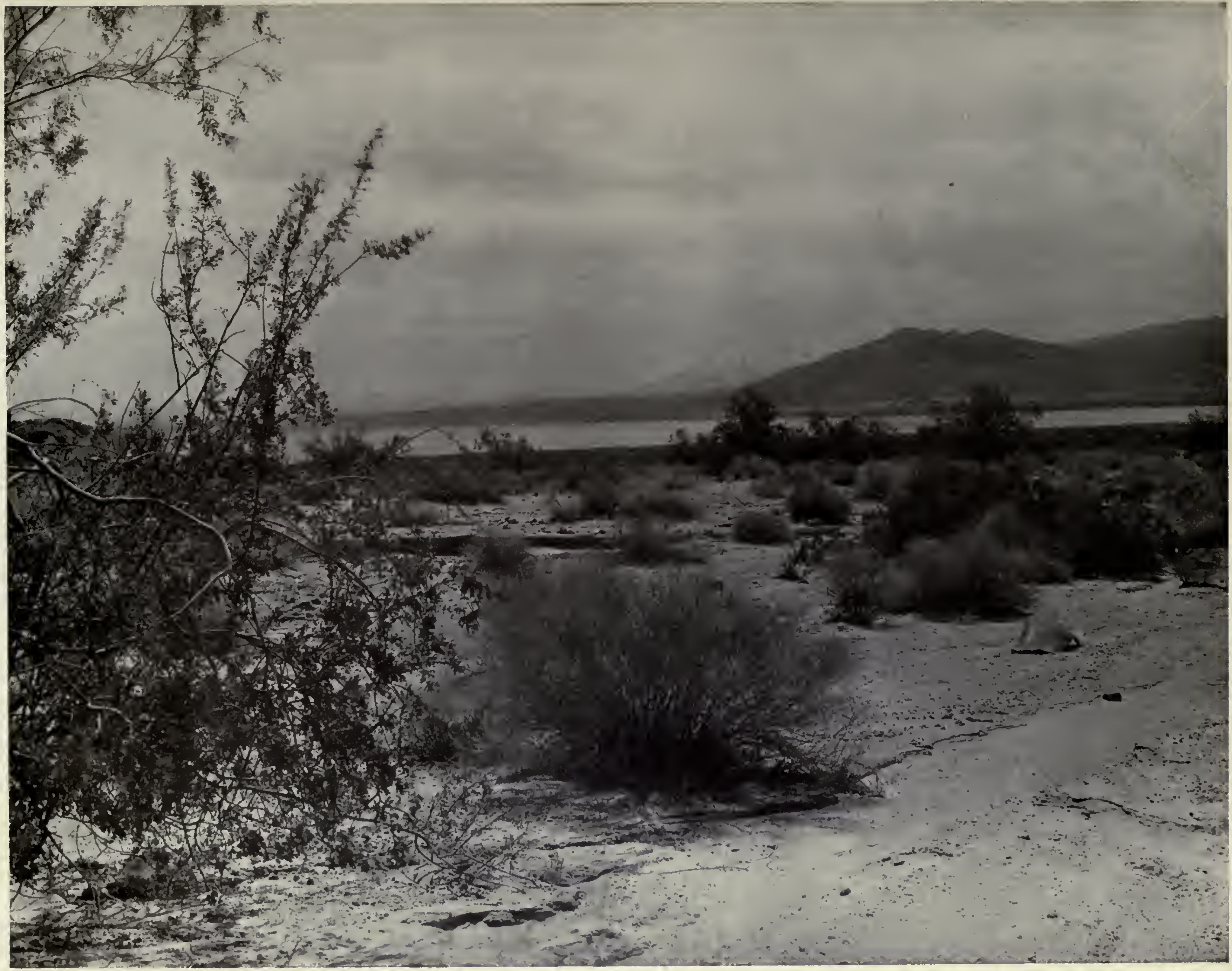
Much of Death Valley, too, is below the level of the sea, down to a depth of nearly three hundred feet. This depth adds to the heat of the region through the compression of the air as it sinks into the trough, so hot that Death Valley's official record reports the thermometer having



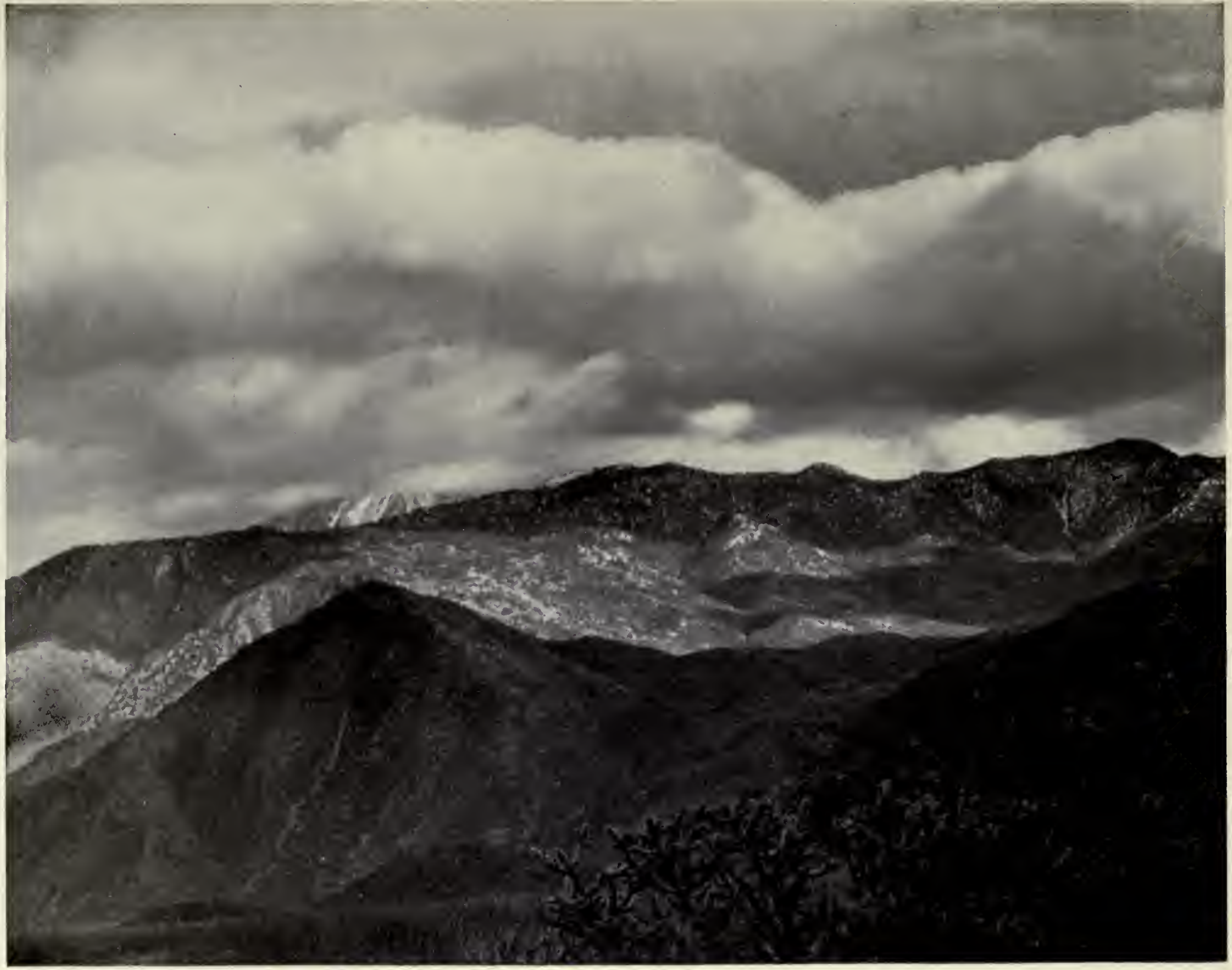
8. SPANISH DAGGERS BLOOM IN DESERTS MADE BY MOUNTAINS LIKE SNOW-CAPPED OLD BALDY



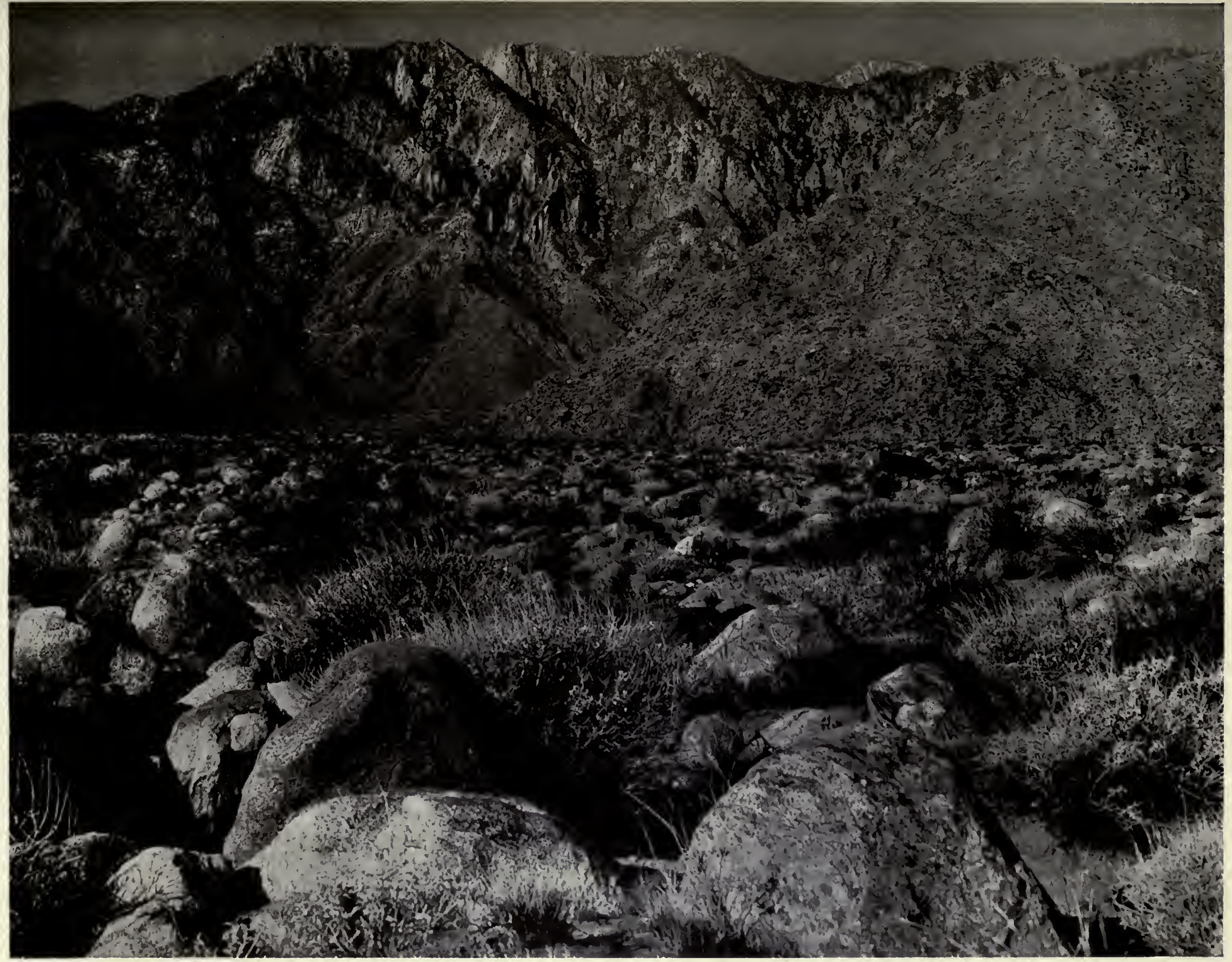
9. A FRAGMENT OF THE DESERT OF THE COLORADO, MADE BY SNOW-CAPPED SAN JACINTO AND ITS NEIGHBOR MOUNTAINS



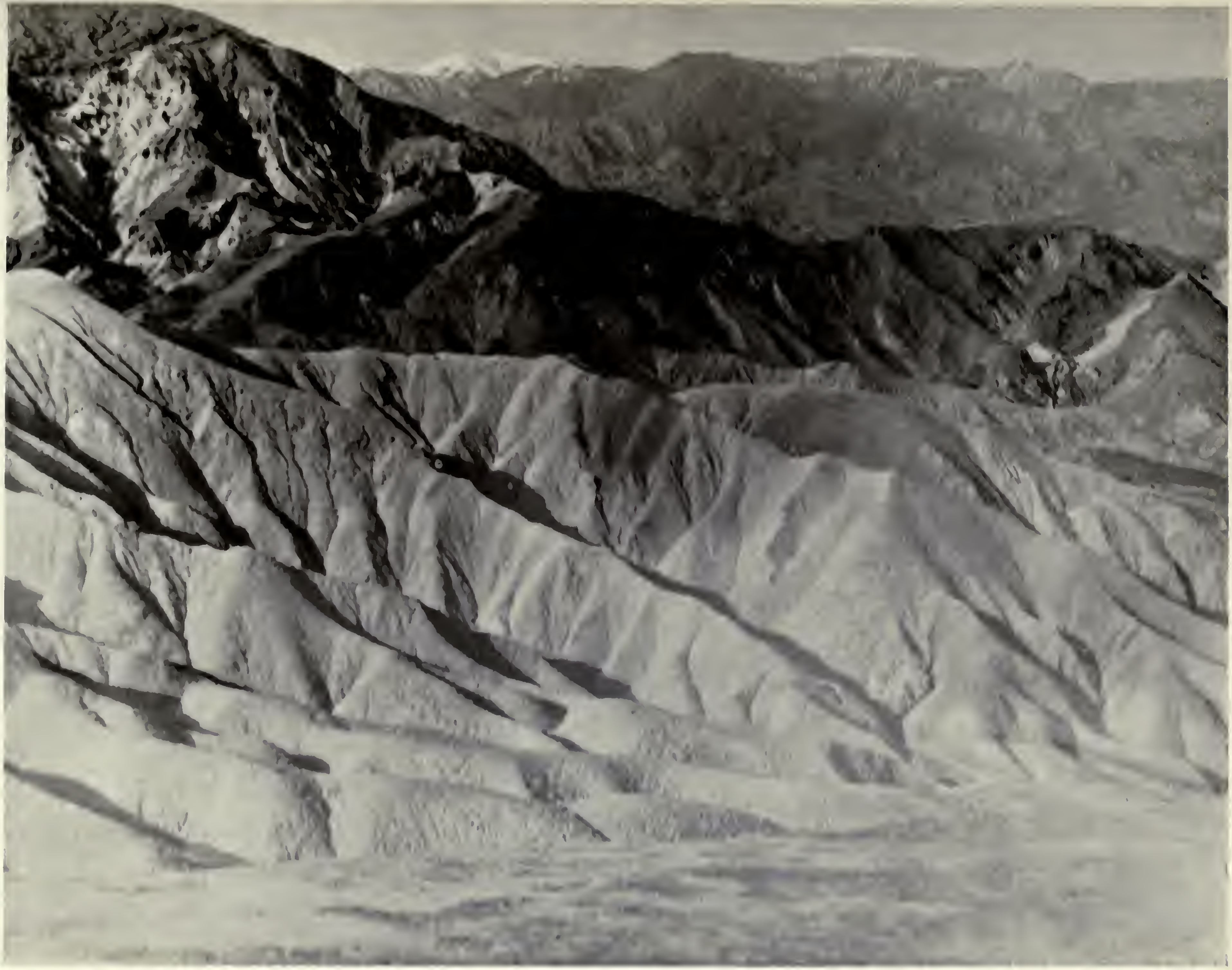
10. BELOW THE LEVEL OF THE OCEAN IN THE DESERT OF THE COLORADO, AT THE NORTH END OF SALTON SEA



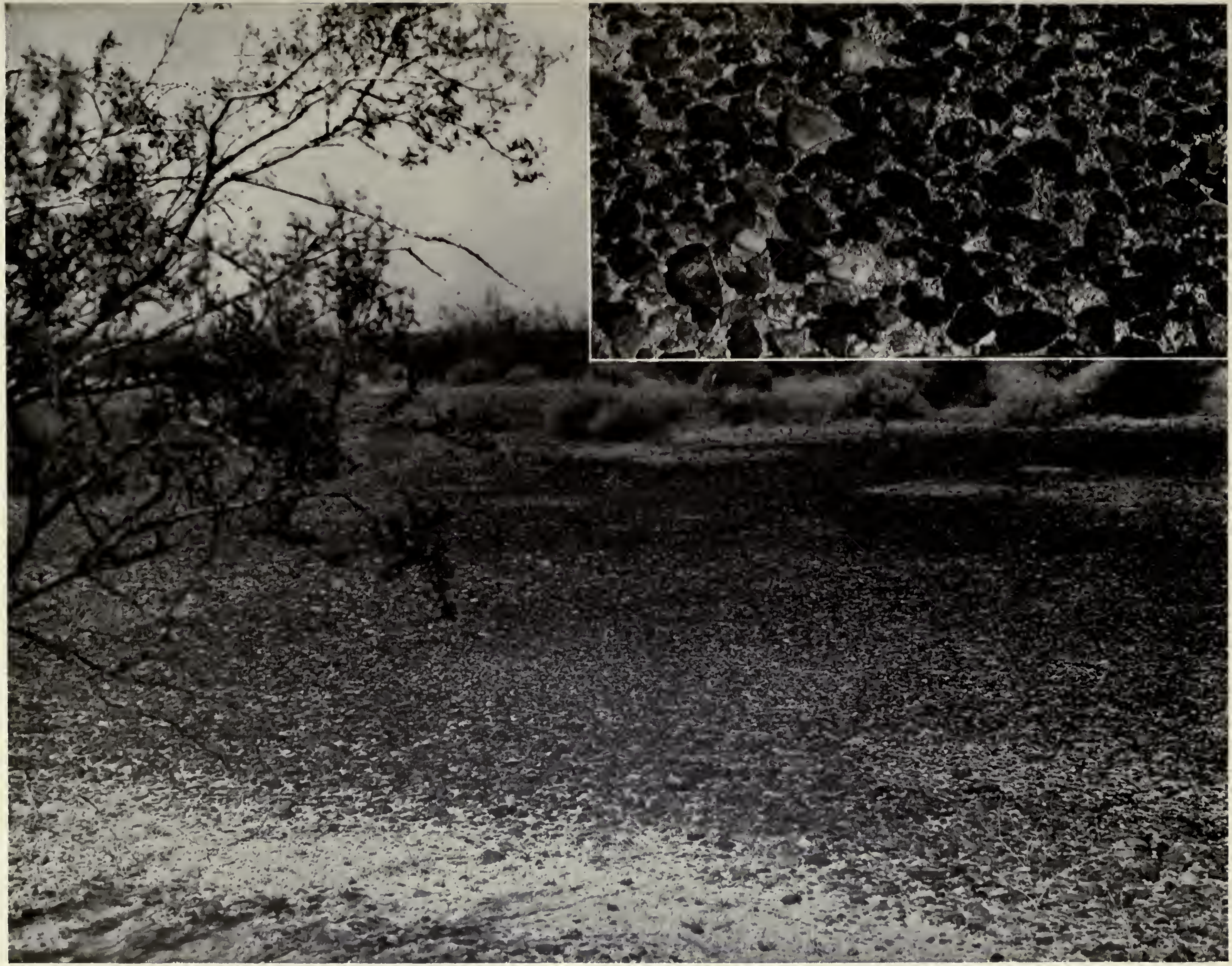
11. CLOUDS ABOVE THE DESERT MOUNTAINS OF THE SAN JACINTO RANGE



12. GIGANTIC BOULDERS IN A CLOUD-BURST FAN AT THE FOOT OF A DESERT MOUNTAIN



13. BETWEEN THESE BLACK MOUNTAINS, WITH THEIR RAIN-GOUGED RAVINES, AND THE SNOW-CAPPED PANAMINTS BEYOND, LIES DEATH VALLEY



14. A WIND-MADE DESERT PAVEMENT IN THE MOHAVE

risen to a high of 134 degrees Fahrenheit in a regulation thermometer shelter. How hot does it become in the blazing sun on the beds of salt? No one has ever learned.

As in all desert regions, strong winds blow in Death Valley. The winds pick up the desert surface and carry it in a stream along the trough. Where an interruption in the strong draft may occur, caused by an outjutting spur of the Panamints as at the mouth of Emigrant Wash, an eddy forms and the sand sifts out to drop to the ground to be molded into dunes with the marks of wind ripples (Illustration 1).

Wind does not always blow in Death Valley, and it is not always hot, of course. Its weather in winter is often pleasantly cool, even sparkling. In the winter of 1936–1937 a trace of snow actually fell. In late March, clouds moved over the valley from the Panamints on three occasions, and once a hard squall of rain deluged us as we drove. The windshield wiper had to be turned on —a windshield wiper necessary in Death Valley! These showers boosted the rainfall to a point well above the year's normal of one and three-quarters inches and left the air clear and clean. So clear that the camera brought out every cranny and ravine in the somber but beautiful Funeral Mountains for Illustration 1. And wild flowers bloomed over a valley floor that seems the height of inhospitality to delicate blossoms.

DESERT RAINS AND DESERT SURFACES

Desert surfaces are the result of sun, or heat, and cold, and of wind; but directly or indirectly, the rain plays as great a part as any other agency. Over the Mohave, old lake beds present their dust-fine surfaces. These are the desert playas. "Dust devils," whirling columns of wind, march across them in the quiet heat of midday. The material of the playa was brought down from desert mountains in the silt and salt in the runoff of desert rains. These same lake beds contain many minerals which have been deposited there.

The gravel and sand that compose most of the surface of the Mohave beyond the playas are the result of the disintegration of old mountain granite, or other rock, brought about through the action of rain in connection with the heat of the sun and with temperature changes. With the wind's help, this same gravel is bedded down in places with rain into the interesting and strikingly level desert "pavements."

Sand dunes are chiefly the playthings of wind, but water and rain had their part in making the sand. The entire desert is not sand, however. Much of the Mohave surface, as has been noted, is the fine silt and rocks of playas, or a coarse gravel. The Colorado is the typical sandy desert. East of El Centro there exist dunes so fine and so vast that the motion-picture companies put their Arabian and Saharan sets upon them.

Other desert surfaces that are the result of rain may be mentioned. These are the silt fans that spread out over the desert from every mountain canyon. On a clear winter day, one can stand on the south side of the Coachella Valley and look across at the picturesque Little San Bernardinos. The fans spread out from these mountain bases in marked regularity, connected with fanlike gorges just above. They are mountain monuments to desert rain.

Descriptions of illustrations of the work of desert rain in building desert surfaces follow:

Clouds above the desert mountains of the San Jacinto Range (Illustration 11). Clouds are one of the most beautiful of desert features; but clouds seldom mean rain to the desert. Rather, the appearance of clouds above the desert ranges means that the mountains that form them will receive their water, and not the parched lands below. The turbulent clouds of the picture were adding inches of snow to Mount San Jacinto's hoary dome, but scarcely a drop of moisture fell on the mountain's desert foot. Great forests grow on the higher slopes, but only devil's gardens grow on the lower piles of rock.

Rains, to the desert mountains, come at all times of the year. The winter rains that give moisture to the lowlands of the West Coast also provide water to the highlands on the fringe of the desert, and often provide the only water the desert itself receives. During spring and summer, thunderstorms rumble above the high mountains, and sprinkles from these grudgingly extend out over the heated sands. On August 18, 1934, for instance, great thundershowers occurred throughout much of Southern California, and newspapers remarked that "even the Mohave received a sprinkle." The great mountains that rim the deserts make clouds and thunderstorms, but give the desert only a sprinkle!

Gigantic boulders in a cloudburst fan at the foot of a desert mountain (Illustration 12). At times, the clouds above the desert mountains let down a torrential rain. The water roars down the barren lower slopes, without trees or shrubs or other plants to restrain it. It picks up gigantic boulders and rolls them upon the desert. We estimated that some of the granite boulders of the picture weighed not less than five to ten tons, and they had been rolled upon the desert sands more than a mile from the mouth of the canyon which spewed them forth. To be reminded of the gigantic hand that cloudbursts play in desert mountains, remember the flood in the Tehachapi Mountains in the winter of 1932–1933. Freight cars were picked up and tossed about in the waters, roadbeds were torn out, and the town of Mohave, five or six miles out on the sandy plains of the desert, was flooded in more than a foot of water.

These floods carve grotesque features in all the desert mountains. Giant crevasses, thousands of feet deep, are cut for the canyons that carry the water. Rock slides tumble down in great sheets of boulders. The mountains themselves disintegrate and weather away with great rapidity in the harsh desert climate, and the desert conquers even the cloudbursts of its mountains, for its thirsty sands soak up the waters of the torrents, and a short distance beyond the spot where the last boulder is dumped not a trace of the water remains.

Between these Black Mountains, with their rain-gouged ravines, and the snow-capped Panamints beyond lies Death Valley (Illustration 13). Though they lie on the margin of Death Valley, and receive in a year perhaps not more than two inches of rain on an average, still the Black Mountains display the work of water in grotesque ravines and gorges. There is no grass to check the water of these desert mountains. There are no trees or shrubs. Rain may come but rarely, but when it comes it falls in torrents. The walls of the Black Mountains, as with all desert mountains, are torn away to form broad fans of silt on the valley below. This view from Zabriskie Point becomes one of the most colorful of a colorful region. Desert rains have made it so.

The Panamints? The snow-capped peak is Telescope. It stands more than eleven thousand feet above Death Valley. The fact that it has snow is one of the reasons for the dryness of Death Valley.

A desert pavement made by wind and rain in the Mohave (Illustration 14). Surfaces of deserts are of several types: the surface may be entirely fine sand, as is much of the Colorado; it may be of barren rock piles at the foot of the desert mountains; it may be the fine silt, or the salt, of the old dried lake beds; it may be of gravel and small stones that have been formed by the breaking down of larger rocks. In the Mohave the lake-bed type is common, and also the gravel. Where the gravel occurs, the rain beds it down into the desert pavements, and the wind blows all the loose sand away until the rock bits settle into a smooth layer. The wind then fills in the chinks with a mortar of drifting sand.

Not far from Victorville, in the Mohave Desert, and for many miles in western Arizona, extensive pavements occur. They are so smooth and firm that a car may easily be driven over them. Again, at the top of the famous Johnson Grade that leads to the summit of the San Bernardino Mountains, a whole slope is covered with a desert pavement. Here large stones are so chinked with sand that the result is a cobblestone flooring.

CHAPTER IV

PLANTS IN THE DESERTS

Deserts are not lifeless wastes; living things are surprisingly abundant there. All life in the desert is faced by the great water problem, however. The methods used by living things in solving it will be the phase of greatest interest to us.

HOW THEY SOLVE THE WATER PROBLEM

Plants that live in terms of days. These are certain of the herbs, those plants that expend no energy in woody stems as do shrubs or trees. The herbs may be annual herbs or perennial herbs. If annual herbs, they come forth after rains, usually winter rains, produce leaves, flowers, and fruits in a short period. After that they die away entirely, for they have produced seeds, the function of a plant, and so may leave the problems of another season to another generation. These are truly the plants that live in terms of days.

The perennial herbs may be evergreen and keep green tops above the ground for years. This evergreen herb condition is common in the tropics and for some of the plants that live in the mild and unsuspected desert of the Pacific Ocean's dunes, but for the true deserts the condition is restricted to the cactuses.

The perennial herbs may be deciduous, that is, lose their tops of stem and leaves and so leave the problem of another season to an underground bulb or rootstock. The bulb or the rootstock is the perennial herb's best answer to the desert's problems. The desert may be summer's dry or winter's cold; and the herbs, annual or deciduous perennial, live in terms of days and so have arrived at Nature's best answer to the desert's water problem.

All types of herbs, annual, evergreen perennials, and deciduous perennials, will be described under "Desert Plant Examples" in this chapter.

Plants that live in terms of years. These are the woody plants, the shrubs and the trees, and such evergreen perennial herbs as the cactuses. All these have the long life that carries them through season after season. These plants cannot answer the desert problems so simply as can the annual herbs or the deciduous perennial herbs, for they must live through periods that may be wet and periods that may be dry with the drought and heat of the desert. They solve their desert problems in several ways:

With their leaves. Leaves have as their great work the making of sugar. To make sugar, they require water and carbon dioxide. The carbon dioxide is secured from the air and the water from the ground. Carbon dioxide presents no problem, but water does. To make the most of the scanty or erratic water supply of desert regions, the leaves present many interesting features. The leaves of most desert plants are gray or gray-green because they have a thick cutin layer, a scurfy covering, a glaucous or powdery surface, or coats of fine wool. All these devices reduce evaporation of water from the leaf's surface. The leaves may also be varnished, waxy, resinous, or leathery. They may be rolled to present only one surface. They may be thick for water storage; they may be very small or finely divided; they may be present for a brief period immediately after the rains; or they may be absent altogether and their places taken by leaflike stems as in the cactuses and the Pickleweed. These are all adaptations of xerophytes, the desert plants. The only brightly green and succulent leaves are those of mesophytes, the plants living where water is abundant, or of deciduous desert plants, which produce their leaves after the slight winter rains and shed them in a few weeks.

With their roots. The root systems of many desert plants are far more extensive than the roots of plants having a more moist habitat. The root mass is many times larger than the plant aboveground. This is strikingly true of the Creosote Bush (Illustration 28). Many of the desert trees live on the margins of the arroyos and reach the underground water by long taproots. Root crowns, the broad basal stems at the surface, serve in part as a means of moisture storage for some, such as Ocotillo (Illustration 25).

With their stems. The stems of most desert shrubs and trees are expecially tough, hard, and resistant to drying. This has arisen chiefly because of their slow growth. The stems of some desert plants have added to their ancient function of leaf support other interesting functions. Cactuses, for instance, have reduced their evaporation problem by eliminating leaves and thereby reducing their surface. The stems replace the leaves by taking over the starch-producing green coloring matter, and, in addition, serve as water-storage vessels. Palo Verde is the "green tree" because the stems have green coloring matter to take over some of the functions that the small and very transitory leaves cannot completely accomplish.

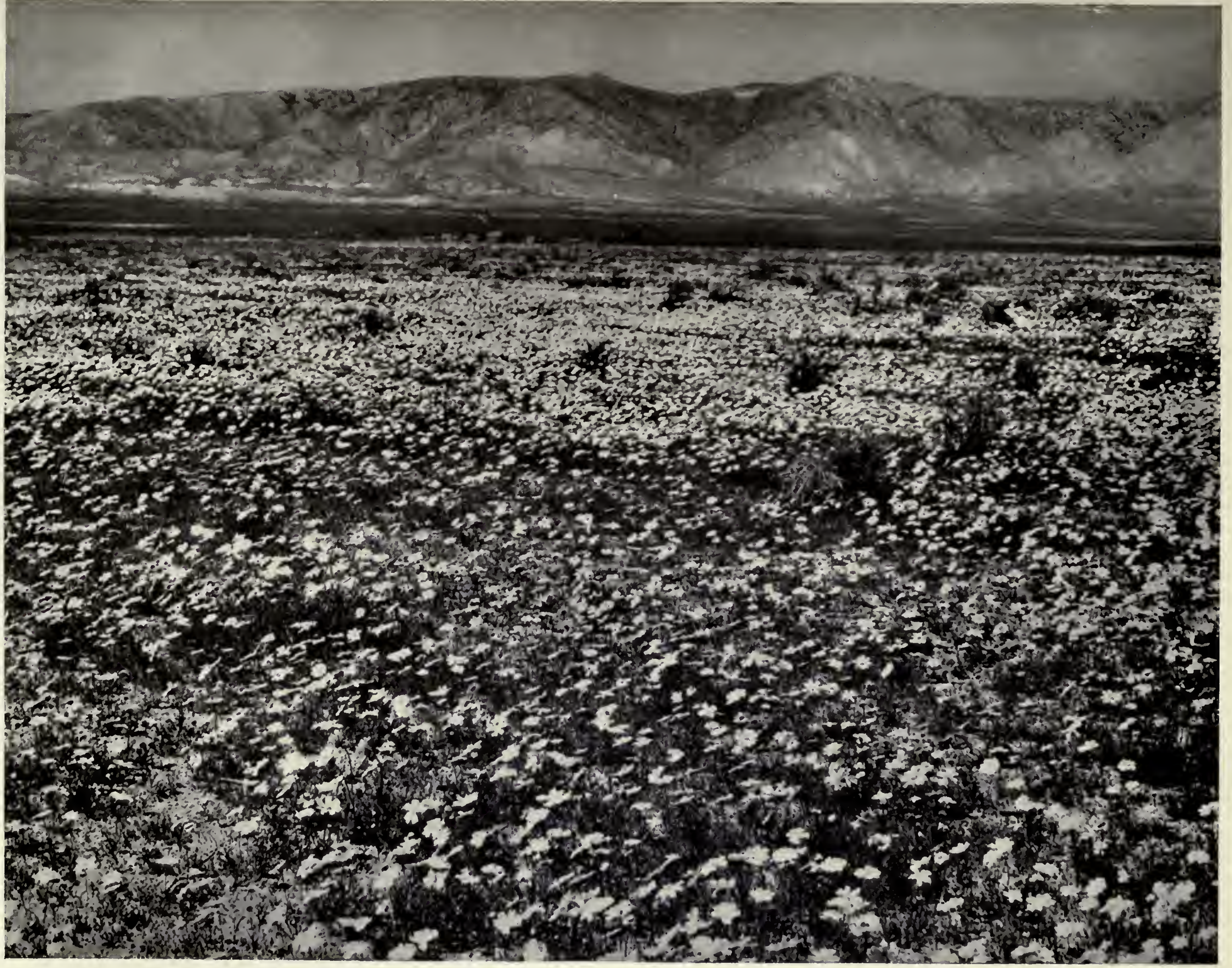
With desert plant hardihood. In addition to all the methods and devices employed by desert plants in meeting their water problem, there is one other. This is sheer hardihood. Desert plants have been selected by nature as those best fitted to survive in trying conditions. They have a fortitude that clings to life even though no rain falls for several years. Part of this intangible fortitude is supplied by the nature of the plant's sap. In some physical way, probably through higher viscosity, it dries tardily and reluctantly. This is, perhaps, the most important device by which desert plants meet their water problem.

Thus with seeds or bulbs to tide them over the "great dry," with leaves of various types and forms to resist the desiccation of the desert winds, with stems to take over leaf functions and to make a storage, with roots to seek far and deep, with liquids that are made to dry but slowly, with a basic fortitude above that of other plants—with these provisions the desert plants solve the water problem.

DESERT PLANT EXAMPLES

The Mohave Desert in blossom (Illustration 15). The stark desert blooms with a flame of colorful annuals when winter rains fall a little more abundantly than usual. The seeds in the sand wait for this day and then they germinate and spring forth to make a vast carpet of color in the desert March or April world.

The prime function of all higher plants is to produce fruits or seeds so that there may be more plants like them. The annuals, or annual herbs, it has been said, serve this function best where desert conditions may prevail. The seeds of annuals of the dry deserts wait in the sands a year, perhaps several years, until rains come. Then with amazing rapidity the seeds sprout, the plants spring from the sand, and bloom. No great energy is wasted in stem, and only a minimum number of leaves appear. The blossom is the



15. THE MOHAVE DESERT IN BLOSSOM

thing, for the blossom produces the seeds. Deserts are covered with bloom for a few days only; after that all flower color disappears, and the seeds, for the next great display, wait unseen among the grains of sand.

The yellow flower that is making the great display in the Mohave is Coreopsis (*Coreopsis calliopsidea*).

Desert Evening Primrose (Illustration 16). Where the world is lavish with water, as in the world of mesophytes, evening primroses may bloom on stems that are head-high. But stems require energy and water, so the evening primroses of the desert, like true xerophytes, grow very short stems, or no stems at all, as does this Desert Evening Primrose (*Oenothera caespitosa*).

With a beautiful rosette of leaves against the sand to make the food, the Desert Evening Primrose blooms like a jewel atop a crown and produces its seeds in a few short days and then dies, for it, too, is an annual herb.

Prickly Poppy (Illustration 17). Journeys in the deserts of California, Nevada, Arizona, and New Mexico, through the spring and early summer, will often show clusters of the surprisingly white, surprisingly prickly, Prickly Poppy (*Argemone platyceras*). This flower seems so out of place in the dry sands of summer that one wonders how the delicate blossoms survive. That is, one wonders until an attempt is made to pick the blossom. Then prickles, as sharp as those of a thistle, give a new respect for the hardihood of the sturdy poppy.

The Mexicans call this plant the Chicalote.

Desert Verbena (Illustration 18). The leaves of the Desert Verbena (*Abronia villosa*) have viscid fluid and are varnished and gummy. This covering gives the Desert Verbena a protection against the drying effect of the desert sun, and though the plant is an annual herb and blooms only during the early desert spring, it survives the desert heat for a longer period than do most of the other herbs.

Verbenas are plants of the sand, wherever they may occur. They cover the dunes along the Pacific Ocean (see Illustration 4); and in the sands of the Coachella Valley the Desert Verbenas give a lavender color, at times, to great stretches of the desert.

Squaw Cabbage (Illustration 19). When the desert rains have fallen properly, the swollen stems of Squaw Cabbage grow in circles about the Creosote Bushes in the Mohave, like children in ring-around-the-rosy. Near the top of the clubby stem, a cluster of deep red blossoms forms.

Squaw Cabbage (*Streptanthus inflatus*) can produce its lush and hollow stem only when more than usual rains have fallen in the desert. Years may pass without a living plant making an appearance. The late winter of 1932 was unusually wet in the Mohave, and in March nearly every Creosote Bush, over large areas, was surrounded by the curious plants. In March, 1933, and again in 1934, not a living Squaw Cabbage was to be seen, though the dead and whitened stalks of the plants of another day still played their game in pantomime about the Creosote Bushes.

Desert Lily (Illustration 20). Here is one of the greatest surprises of the deserts, this beautiful and delicate plant growing where one never expects to find a lily. It (*Hesperocallis undulata*) grows, however, in the hot sands and on the rocky hills of the eastern Mohave Desert, in the Colorado Desert, and in the Sonoran Desert of western Arizona. Of course, it doesn't grow when the sands or rocks are very hot, but brings forth its crumpled leaves and beautiful blossoms only in late March or early April.

All the desert plant examples given to this point in the chapter have been annual herbs, living as plants for one short season only and then perishing altogether, but the Desert Lily is a deciduous perennial herb because it loses stem and leaves when hot weather comes and then survives to the next wet season by means of an underground bulb.

Sea Fig of the unsuspected desert by the Pacific Ocean (Illustration 21). The Yellow Sand Verbena of Illustration 4 supplied one example of a plant in a desert beside the sea, but here is Sea Fig, more a xerophyte even than the Yellow Sand Verbena. For note that the leaves are three-sided and form little tanks for water storage, and so exceed the storage capacity of the thick leaves of the verbena.

The three-sided leaves of Sea Fig (*Mesembryanthemum aequilaterale*) present an interesting problem in the proportion of leaf surface to capacity. Evaporation takes place on the surface of a leaf, and storage is within the leaf. The problem is to get much storage room with a minimum of surface. Mathematics will prove that, for a given capacity, a sphere has the smallest surface area. Spherical leaves do not exist, but Sea Fig approaches it with three-sided leaves, approaches it more nearly with its surprising leaves than do the leaves of any other plant, even the best of the desert lovers.

Sea Fig is listed as an evergreen perennial herb, and so differs strikingly from such a perennial herb as the Desert Lily, for the top or aërial portion of Sea Fig does not die to meet a season especially severe, but persists evergreen for many years. The reason is clear: Sea Fig lives in a desert that is not hot, but always mild with the mildness of the Pacific. Its desert is dry, of course; so it seeks for water with long roots and lives on from season to season.

Sea Fig brings us to those most curious of all desert herbs, the cactuses. They are herbs, because they are succulent and have little woody tissue as do shrubs or trees, but they differ from annual herbs in that they live for many years. They are perennial herbs but, unlike the Desert Lily, they present a top aboveground as long as they live. They are perennial herbs like the Sea Fig and evergreen, but they have no leaves at all.

Leaves are the structures of a plant from which water evaporates most extensively. Thus, as we have seen, leaves become a problem in a desert. The cactuses solve that problem by having no leaves. For most plants, leaves are necessary to carry the green coloring that makes sugar, the plant food, so the cactuses, with no leaves, have the green coloring in their stems. In addition, the stems are thick and succulent with water storage, and usually heavily armed with protecting spines. The deserts have many of these leafless evergreen herbs, which usually have their greenness concealed under a gray covering. A few examples will be given.

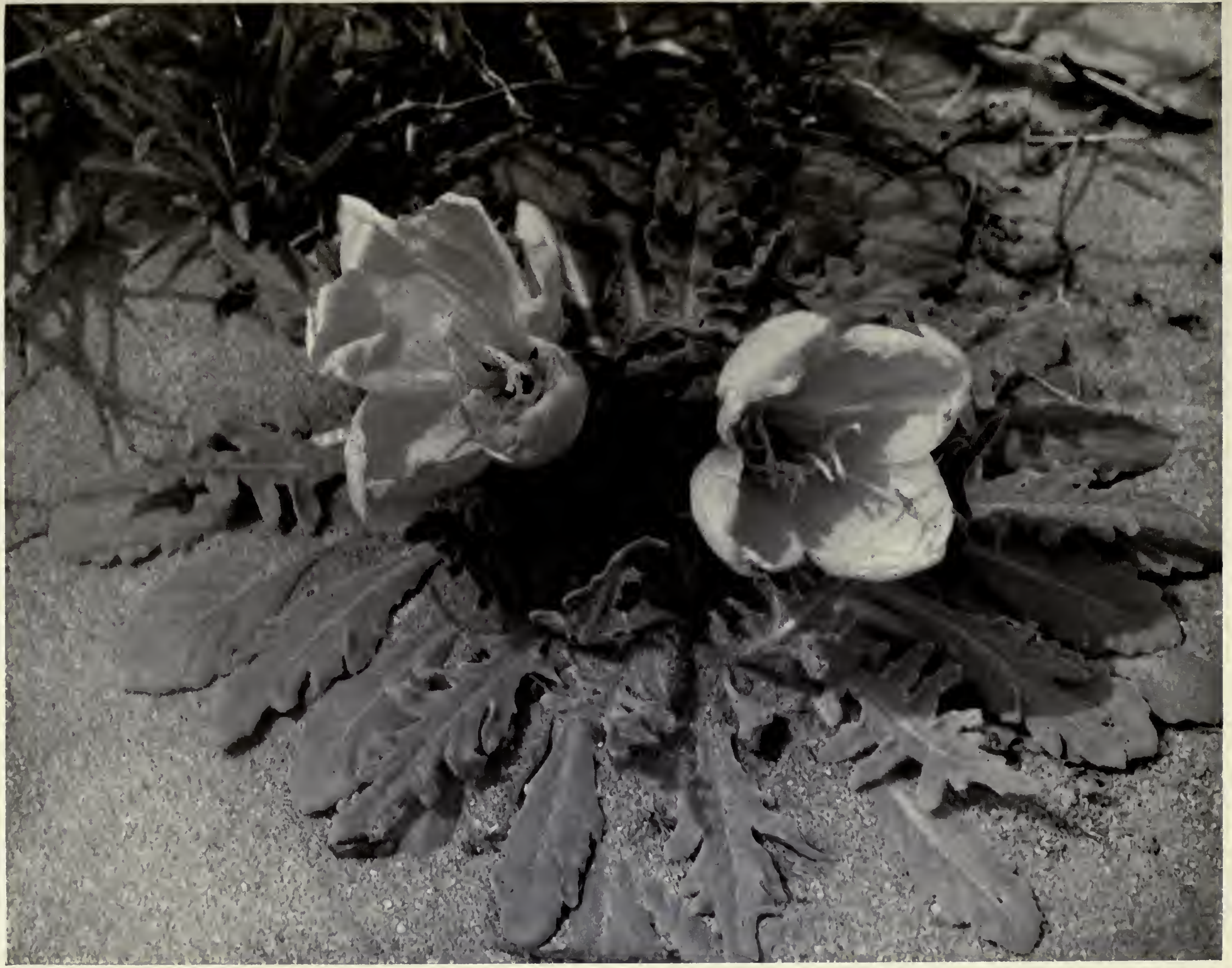
A desert devil's garden (Illustration 22). At the foot of desert mountains, where the canyons dump forth their cloudburst fans of boulders, the devil's gardens grow. Water in great abundance pours into these gardens at times; in fact, the whole garden is wiped out now and then by torrents. But long months of shriveling heat will be the lot of the devil's garden between each rush of water. To be a part of the garden, among the boulders, each plant there must be sturdy and tough. In addition, it must have great systems of roots near the surface of the ground to make the most of the short days when water seeps among the rocks and gravel.

The Barrel Cactus (*Echinocactus cylindraceus*) is the large plant in the foreground. It may reach a height of eight feet. Like all cactuses, it picks up water by a great root system, and stores it in a pulpy stem. Many are the desert stories of thirst relieved, for man and other animals, by chewing the moist pulp of this "barrel." The cactus with the numerous joints is the notorious Cholla (*Opuntia bigelovii*), the "Old Man of the Desert," that grows at times to a height of four feet.

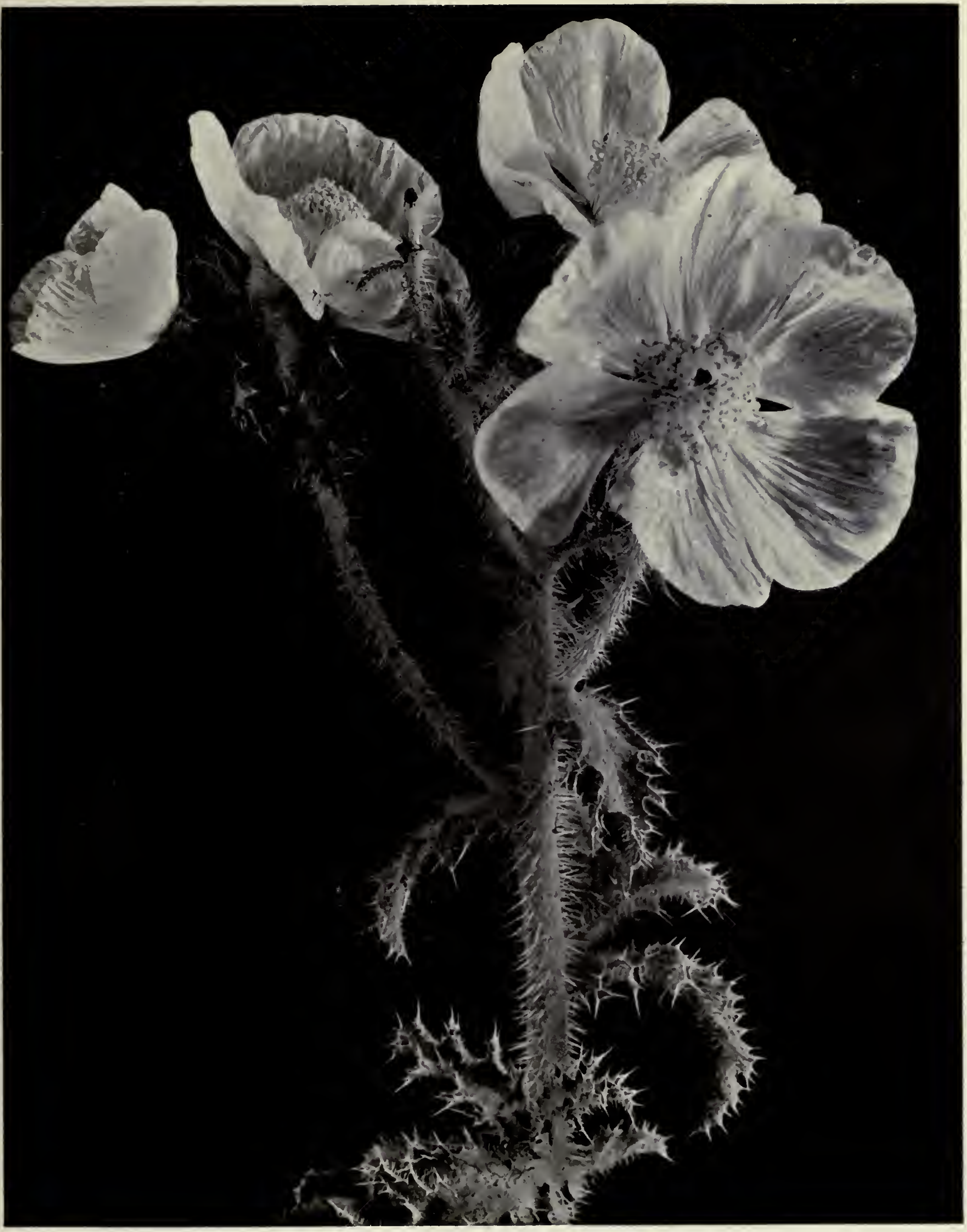
The blossoms in this devil's garden are those of Encelia, which is later described.

The devil's garden is well named: with boulders and "barrels" and "Old Men of the Desert" it is a grotesque feature of the land of sun and wind and freakish rain. But grotesque or not, it captures the imagination and leaves one charmed.

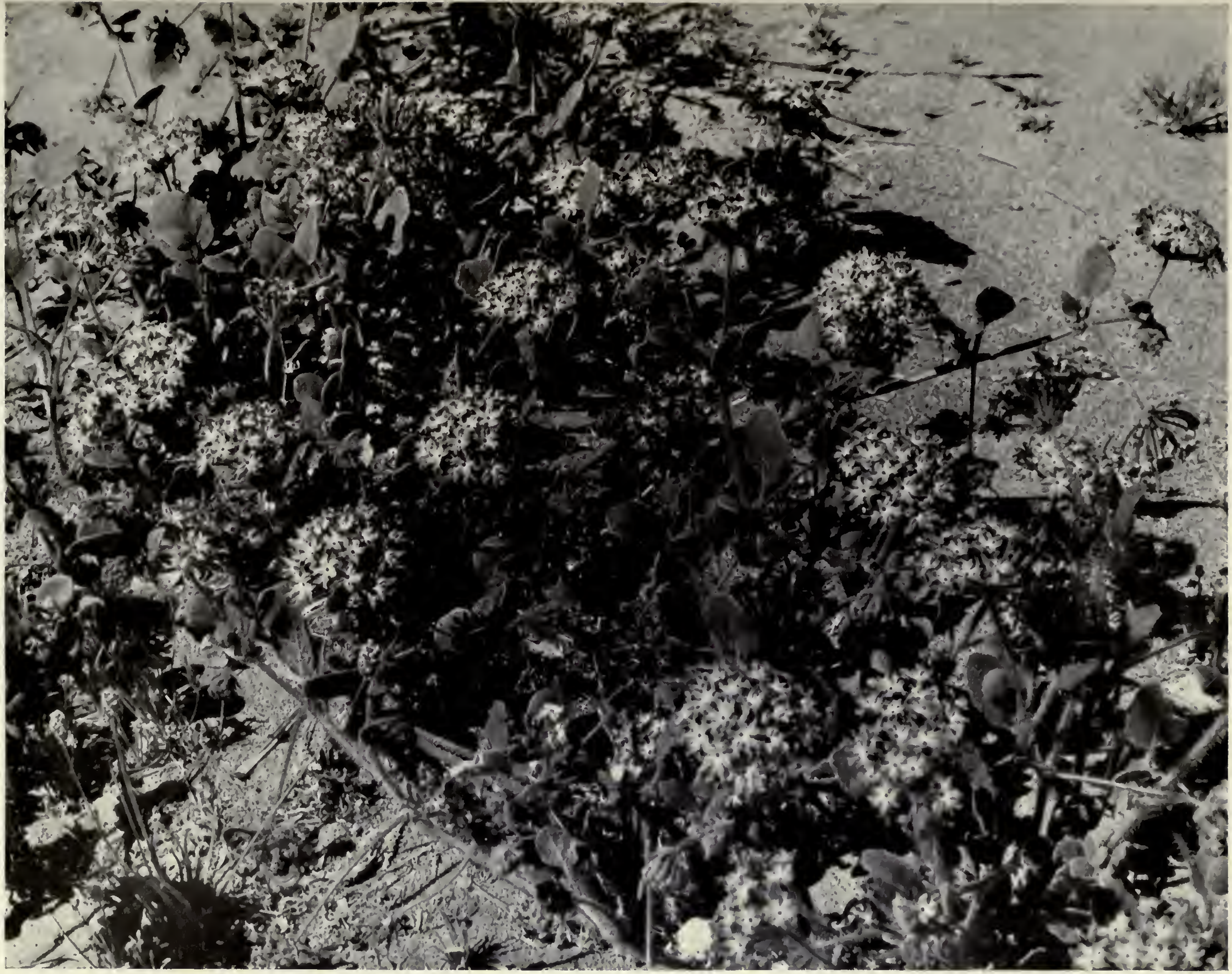
Engelmann's Cereus in blossom beside a Cholla (Illustration 23). In a world of Cholla, Deer-horn Cactus, Barrel Cactus, and Giant Cactus, this little Engelmann's Cereus (*Cereus engelmannii*) is not conspicuous. It may reach a height of only ten to twelve inches, but when it blooms in



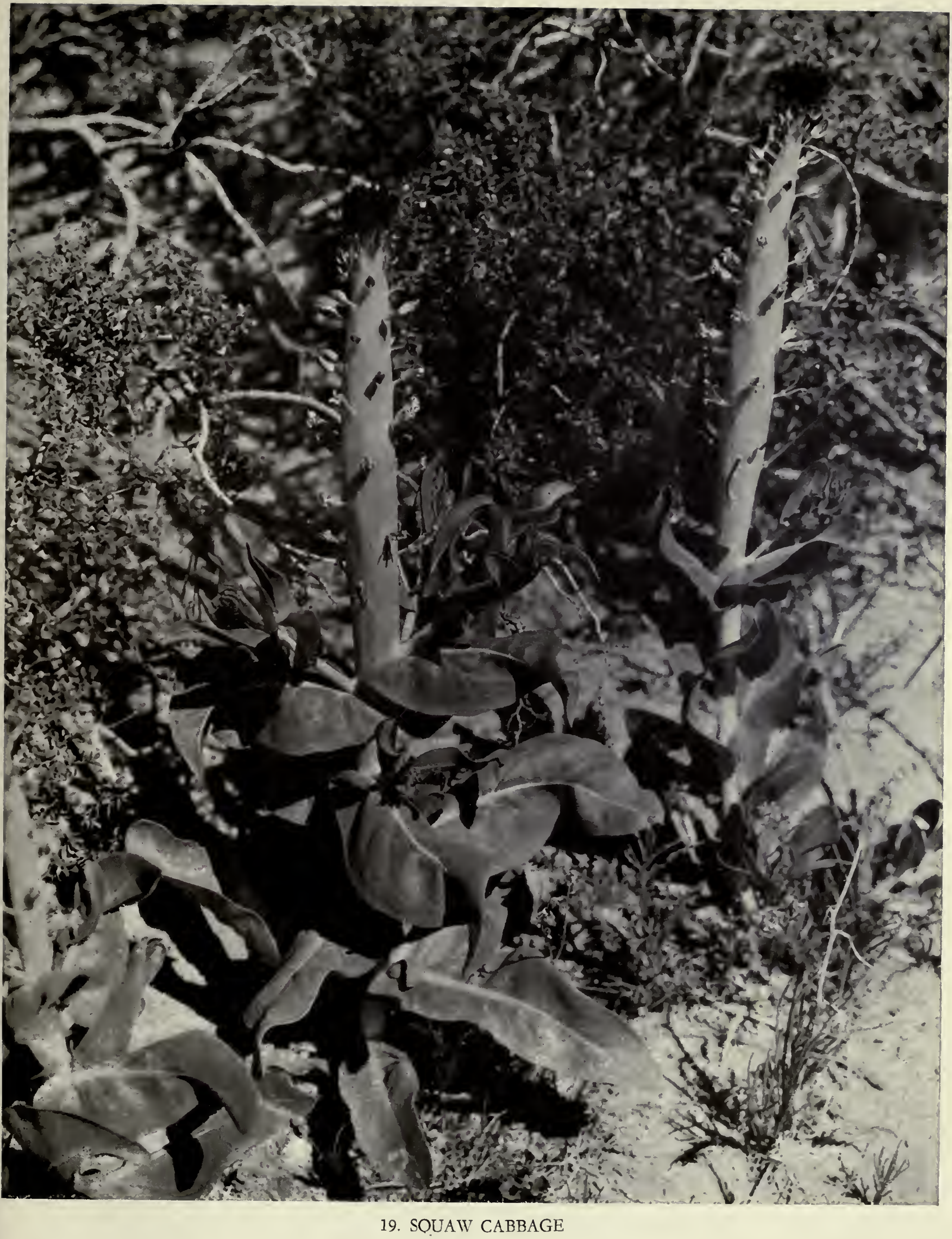
16. DESERT EVENING PRIMROSE



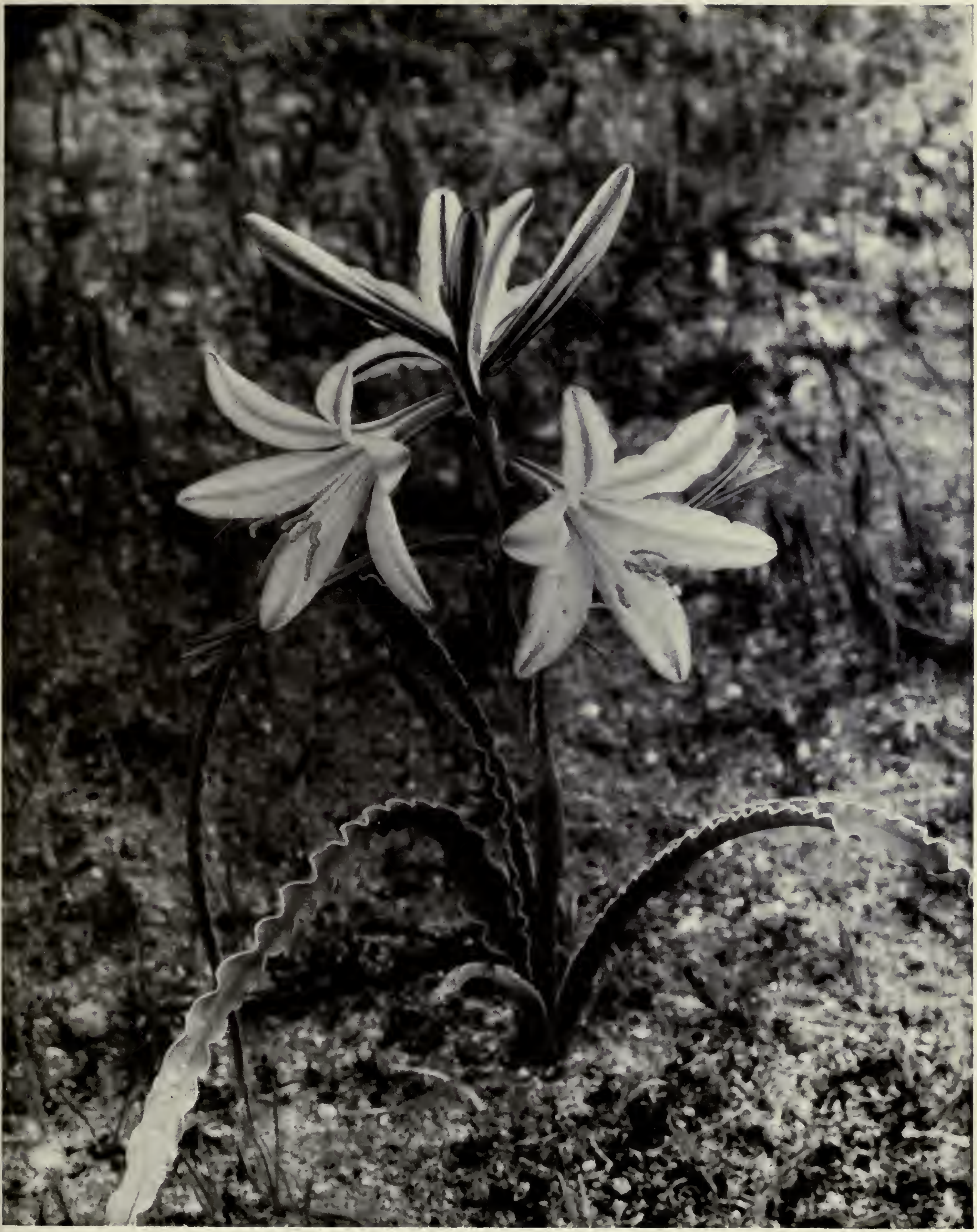
17. PRICKLY POPPY



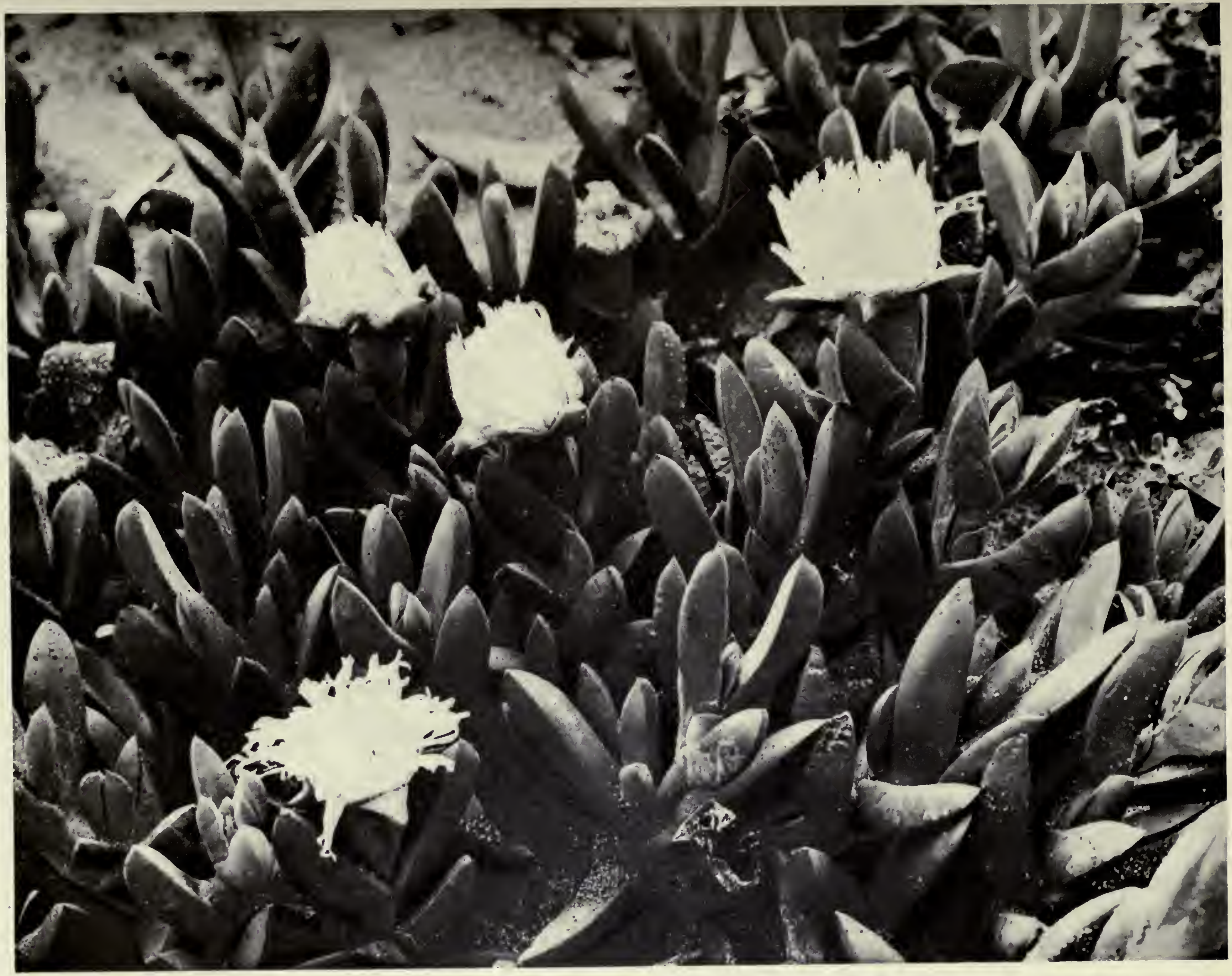
18. DESERT VERBENA



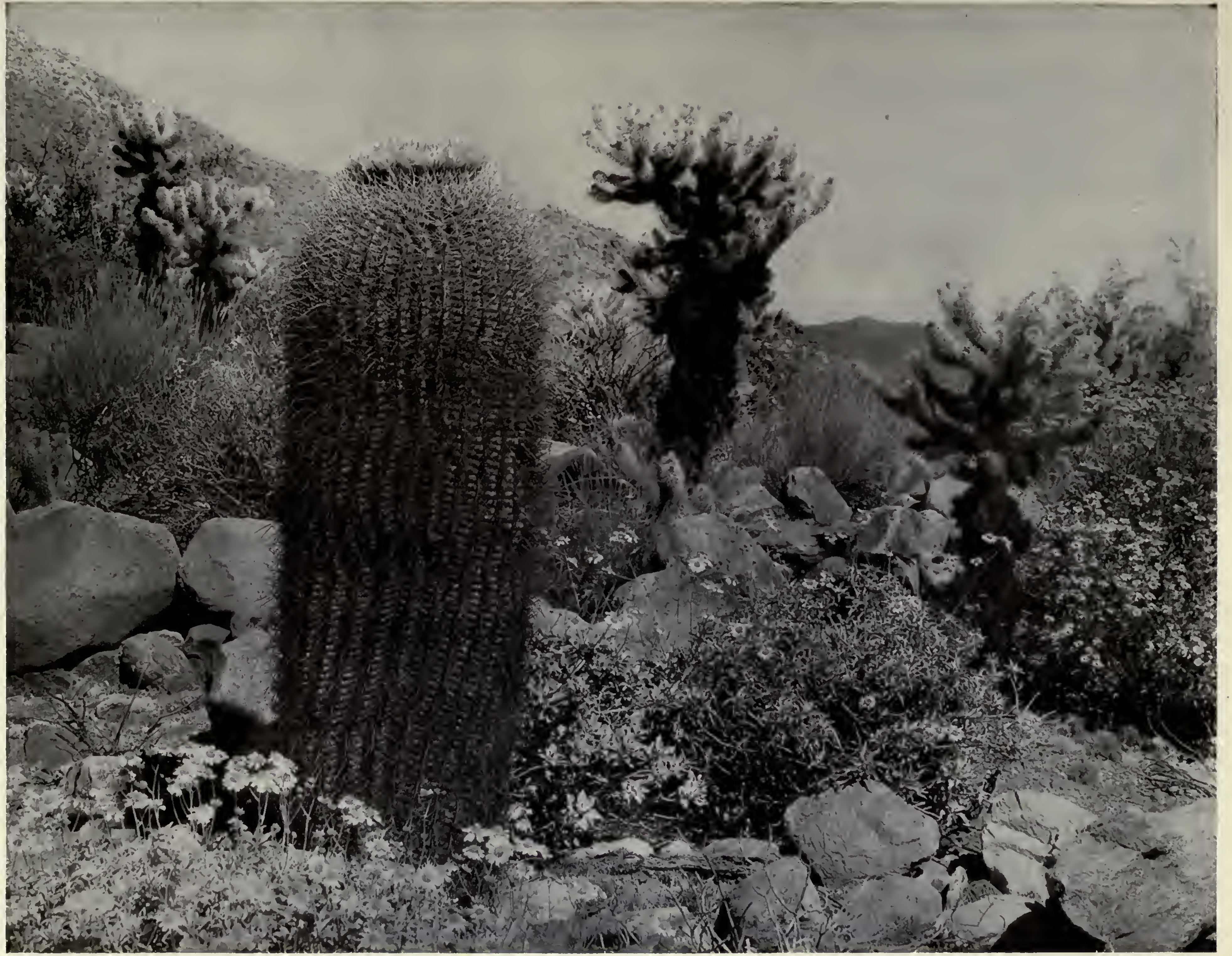
19. SQUAW CABBAGE



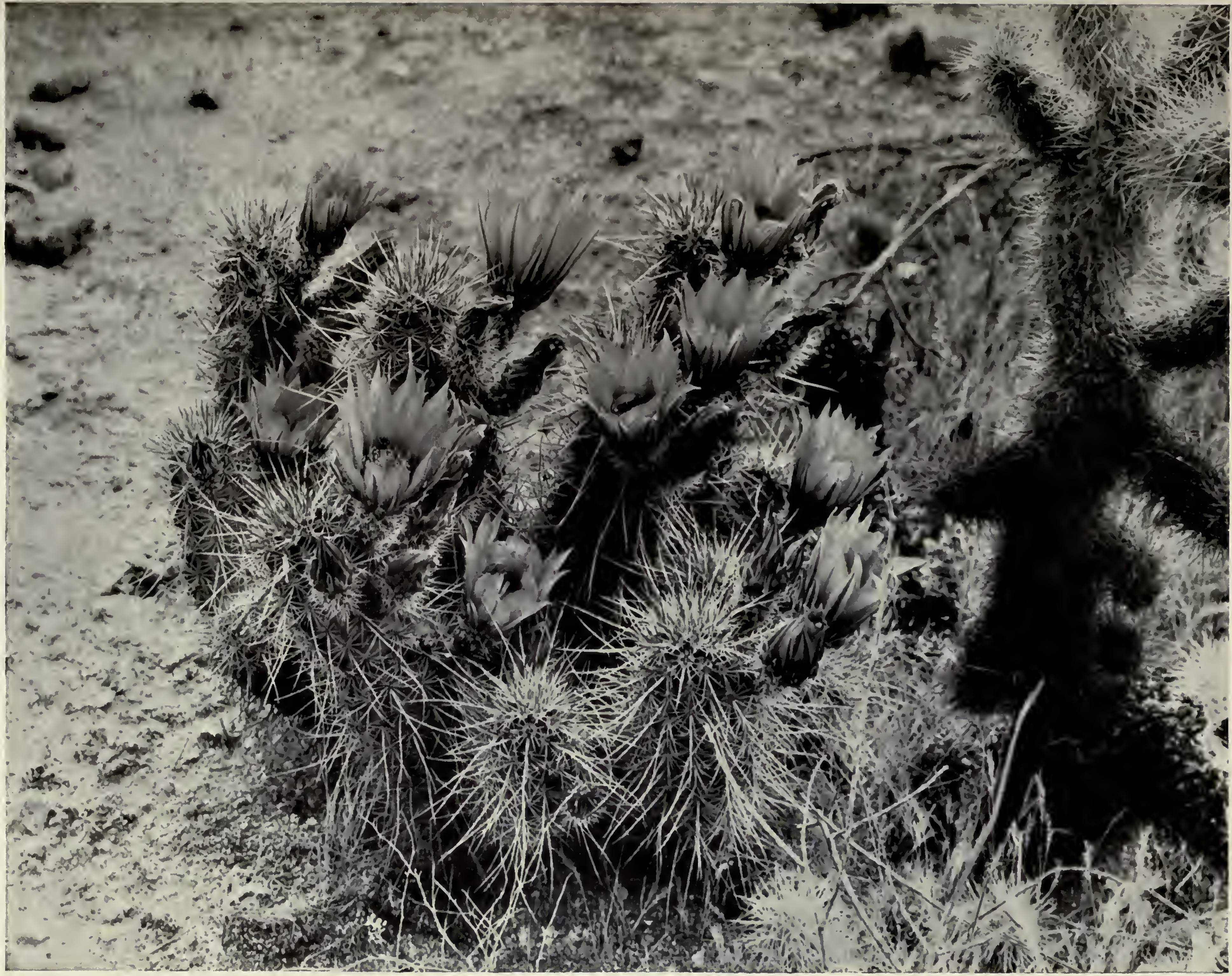
20. DESERT LILY



21. SEA FIG OF THE UNSUSPECTED DESERT BY THE PACIFIC OCEAN



22. A DESERT DEVIL'S GARDEN



23. ENGELMANN'S CEREUS IN BLOSSOM BESIDE A CHOLLA

March its lovely magenta blossoms bring more exclamations than any other. Somehow, the unbelievably lovely blossoms of the cactuses seem a part of the unreal world that is the desert.

The Cereus is beautiful, but its neighbor, the Cholla, is more famous, because of its nature. Every desert traveler knows Cholla, sometimes too well. Its needlelike spines are provided with tiny recurved barbs, and the spines easily leave the stems and stay in the clothing or the flesh when touched. The short stems of Cholla, too, break off and are carried away by any object so unfortunate as to touch them. Cholla distributes itself by means of its stems, for if conditions are right where the stems finally fall, there they grow. So notorious is Cholla that in the desert it is known by many different names: "Silver Cactus" (the new stems at the top are silvery in color, older stems nearly black); "Jumping Cactus" (when the loose stems on the ground are touched, their needles may cause the whole stem to leap, and a journey through a devil's garden of Cholla may give one a painful surprise as a stem, touched by a careless heel, leaps up and strikes the calf of the leg); and most picturesquely, "Old Man of the Desert."

Beaver Tail, a spineless cactus (Illustration 24). The Beaver-tail Cactus (*Opuntia basilaris*), a plant about one foot tall, differs from nearly all other cactuses in that its stems have no true spines. Groups of tiny hairlike prickles occur in the pits, however, and these provide an unpleasant rash when they strike tender parts of the skin. Thus it is that Beaver Tail protects the water reservoirs of its stems against thirsty animals, almost as effectively as does the heavily spined Barrel Cactus, or the murderously barbed Cholla.

Beaver Tail concludes the cactuses and with it the last of the desert herbs. Each herb has its own method of meeting the desert problem. The annual herbs wilt away altogether to meet the dry, whether it be the dry of winter's cold or the dry of the desert's hot. Their seeds carry the line into another season. The perennial herbs, living from year to year, present two or three devices to defeat the desert. Desert Lily, a perennial herb, loses its top and meets the problem of the long dry season with its bulb. It is said to be "deciduous," like the leaf-shedding trees of the winter-cold desert. Sea Fig is an evergreen perennial herb that stores water in leaves. The cactuses are perennial evergreen herbs, too, but they have no leaves and store water in their stems.

The examples to follow are those desert plants with hard and woody stems, the shrubs and the trees. Their persistent stems and long lives give them an advantage over annual herbs and over the perennial herbs that lose their tops, for their leaf support is always ready, but the desert presents to them many problems, nevertheless.

The difference between shrubs and trees is one of degree. The largest desert tree would be a shrub in a great forest of pines or firs, but in the desert it stands above all other woody plants and so merits the name "tree." The desert actually has "forests" of such trees: there are Joshua Tree forests and Smoke Tree forests. Some of these trees and some of the shrubs will be pictured and their solutions of desert problems outlined.

Ocotillo (Illustration 25). Ocotillo (*Fouquieria splendens*) is a Spanish word meaning "little pine," but to the ordinary observer the thorny stems of this most unusual plant look more like a very queer cactus than a pine. But Ocotillo is neither a pine nor a cactus, but a unique plant of the desert. This plant is the only member of the Candlewood Family, but it occurs widely over the desert regions of the Southwest.

The long, furrowed, thorny stems of Ocotillo grow up in clusters to a height of ten to twenty feet, from a huge root crown. It is this root crown that furnishes a reservoir to provide against the long and trying dry periods; but Ocotillo, like all desert plants, has much basic stamina to live in spite of trying conditions.

The long stems of Ocotillo have received many names. One of the commonest is "candlewood," the name of the family; another is "coachwhip."

In March or April, Ocotillo blooms. Blossoms are forming on the stems of the plants of the picture. No more distinctive thrill can be yours on a desert trip than to see the flaming red clusters of blossoms on the upper end of each upright stem. The stems below the blossoms will be armed with robust spines, but not a leaf will show. The leaves, tiny, leathery structures, will appear after the flowers have wilted, will serve their purpose in adding their mite to the store in the root crown, and then they, too, will wilt, to leave the bare and thorny wands of Ocotillo to meet the long months of desert drought and heat.

Encelia (Illustration 26). Encelia (*Encelia farinosa*), a sunflower relative, is a small shrub. As a shrub, its water problem is quite unlike that of such an ephemeral plant as the Desert Evening Primrose. As a leafy plant, the Evening Primrose exists for just a few days, and then only when moisture is present in the sands. It exists in the long moistureless periods as a seed. Encelia, on the other hand, which lives as a little woody shrub from year to year, has a great root system that seeks out the underground water and acts as a storage system.

The Evening Primrose does not show itself at all if proper rains do not come to the desert; Encelia, under those conditions, will conserve its scanty moisture reserve by withholding its blossoms. When conditions are favorable, though, Encelia is one of the joys of the Colorado Desert, for then its soft leaves, gray-green in their coating of white down, cover like plush a two-foot-high pincushion, and foot-long pins, with golden-blossom heads, stand out in all directions.

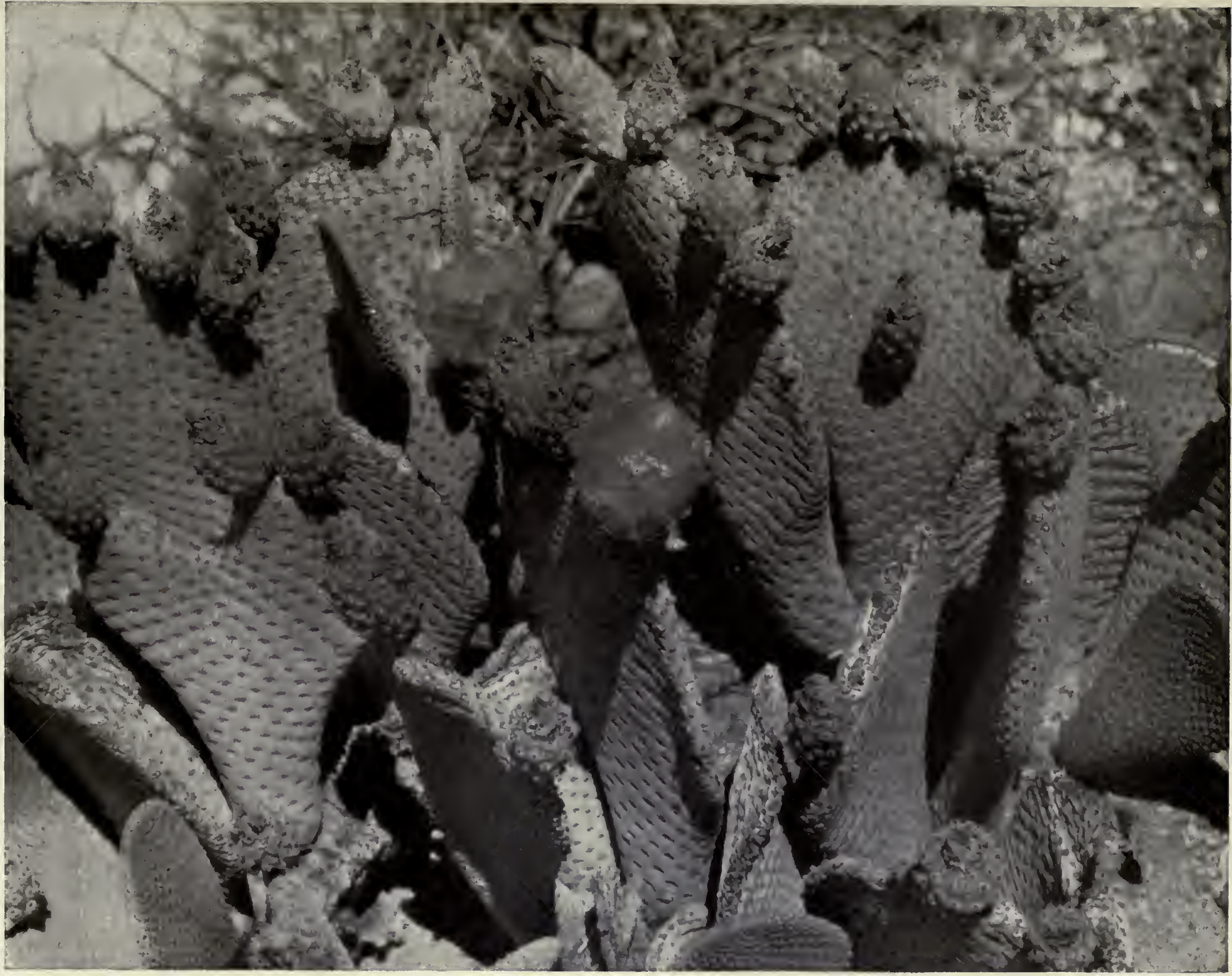
Desert Holly in Furnace Creek Wash at the edge of Death Valley (Illustration 27). Here is another evergreen shrub with the green of its leaves completely obscured by a dense, smooth covering of very small scales that give the leaves a silvery, almost white color. Many desert shrubs are evergreen; and to protect their leaves against the trying yearlong season, most of them have this type of leaf covering. This covering for the leaves of Desert Holly makes of them an extremely appropriate and beautiful feature for desert Christmas decorations.

Desert Holly belongs to a large group of saltbush plants, which flourish, as their name would indicate, on alkaline slopes and flats. These plants grow, thus, not only in the desert of the salt, but in regions that are also deserts of the dry. Desert Holly is the most appealing of all the saltbush group because of its silvery, hollylike leaves, and because it lives in the most severe of desert combinations.

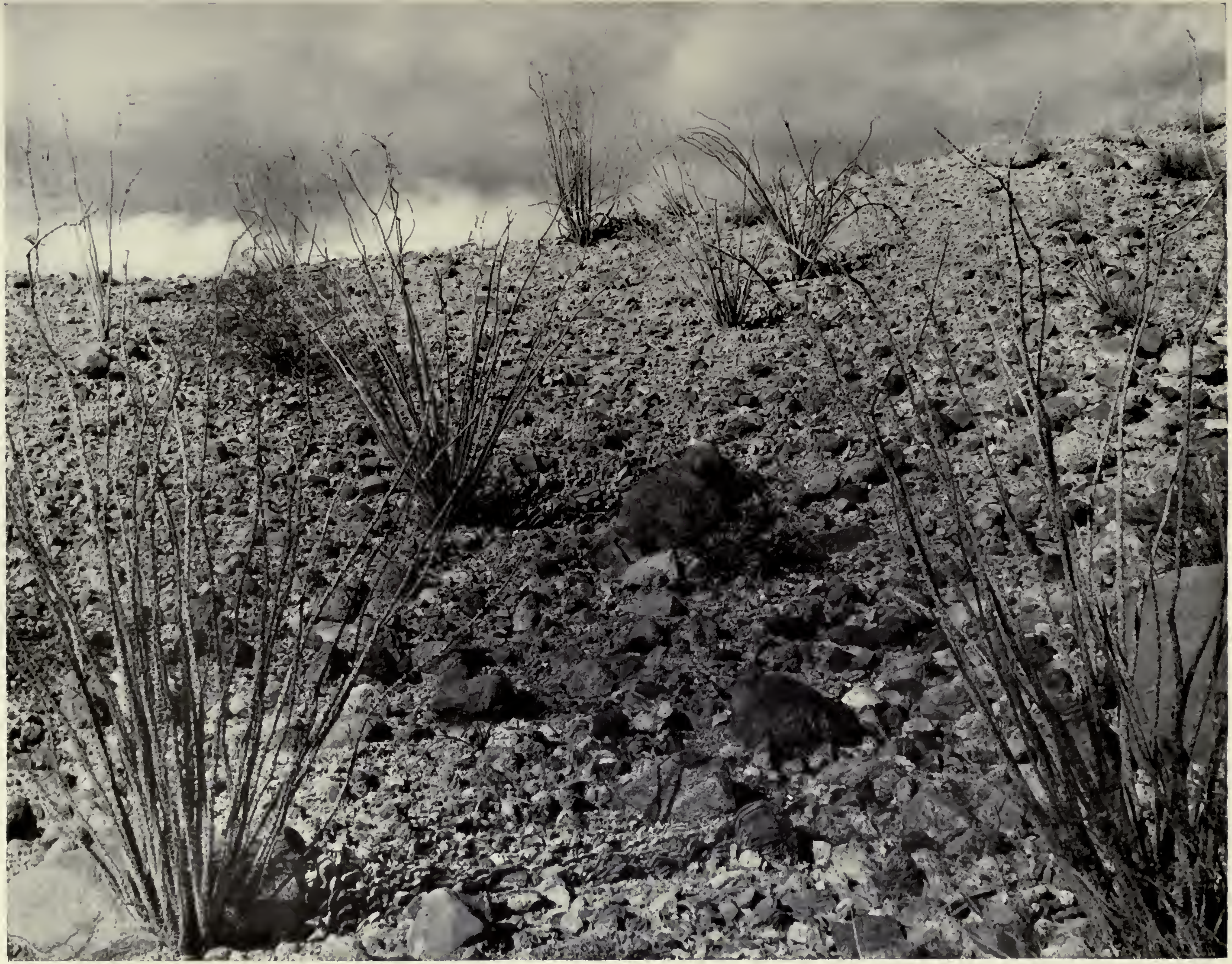
Desert Holly (*Atriplex hymenelytra*) is a true child of the deserts. It occurs in the Colorado and Mohave Deserts, east into Utah and south to Mexico. The Desert Holly of Illustration 27 was growing in a broad wash that leads into Death Valley. Here its four-foot, silvery form was one of the few living things in this most desert of regions. The stark Funeral Mountains behind it serve to emphasize that Desert Holly is a product of the driest of deserts and a striking feature that adds to the charm that deserts hold.

Creosote Bushes on the Mohave Desert (Illustration 28). Creosote Bush (*Larrea tridentata*) is as much a part of the deserts of the Southwest as is the sand. Through much of the Mohave, the Colorado, the Sonoran, and other desert areas to Texas, the Creosote Bush is the commonest shrub. Indeed, over vast, bleak areas it will be the only shrub. It may grow to a height of only five feet, but its shade may be the only shade.

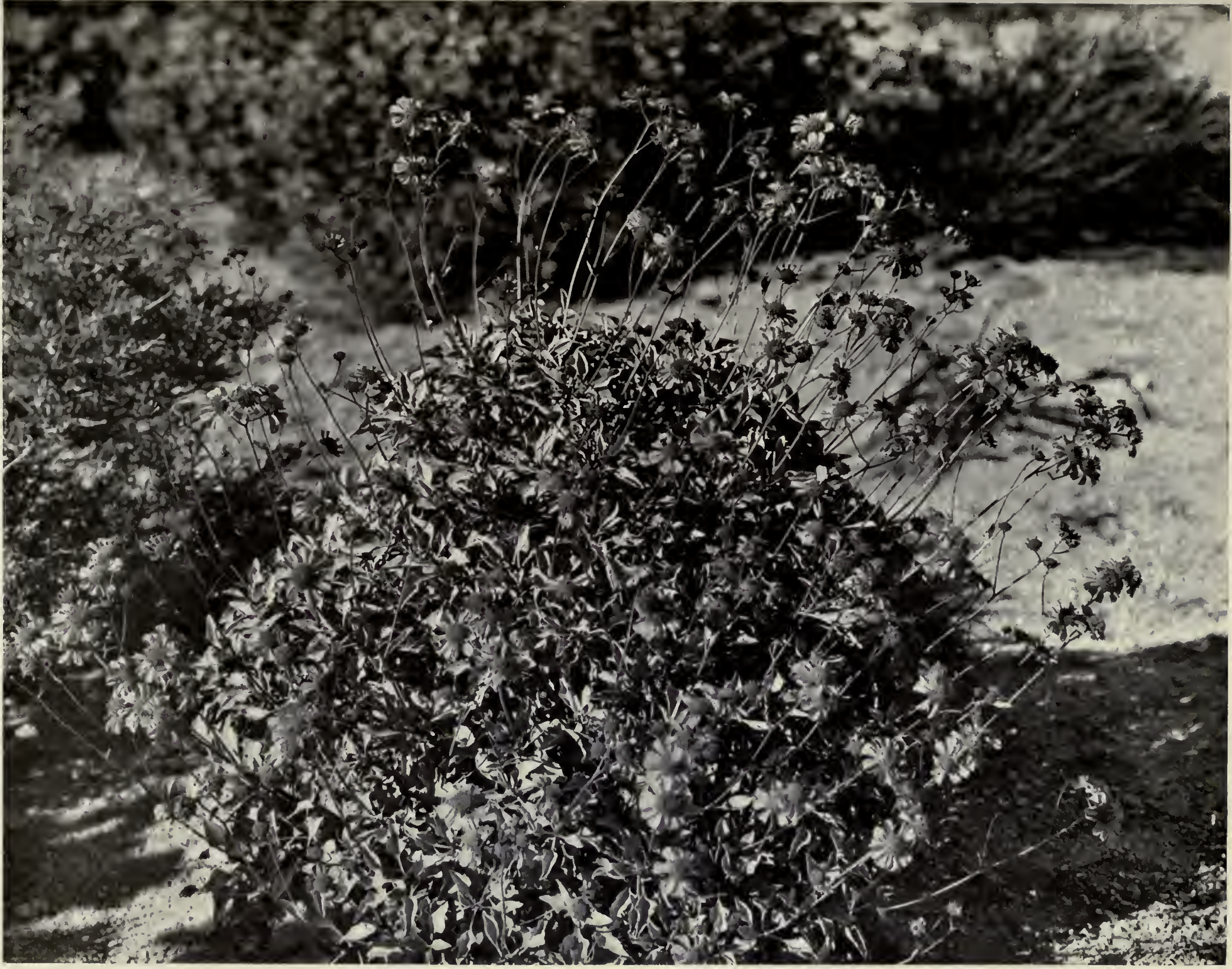
Creosote seems to have solved better than all other plants the problem of existence where heat is intense and rain falls sparingly, or not at all for years. The solution that Creosote Bush brings to desert problems seems to be, first of all, a ruggedness to bear hardships beyond the ability of any other plant in the desert world. It has been known to survive three whole years in which not a measurable trace of rain fell. The root system of the Creosote Bush is amazingly great when compared with the puny shrub above the ground. With such a root system the Creosote Bush searches out all available water. Perhaps to the far-flung root system one can attribute the



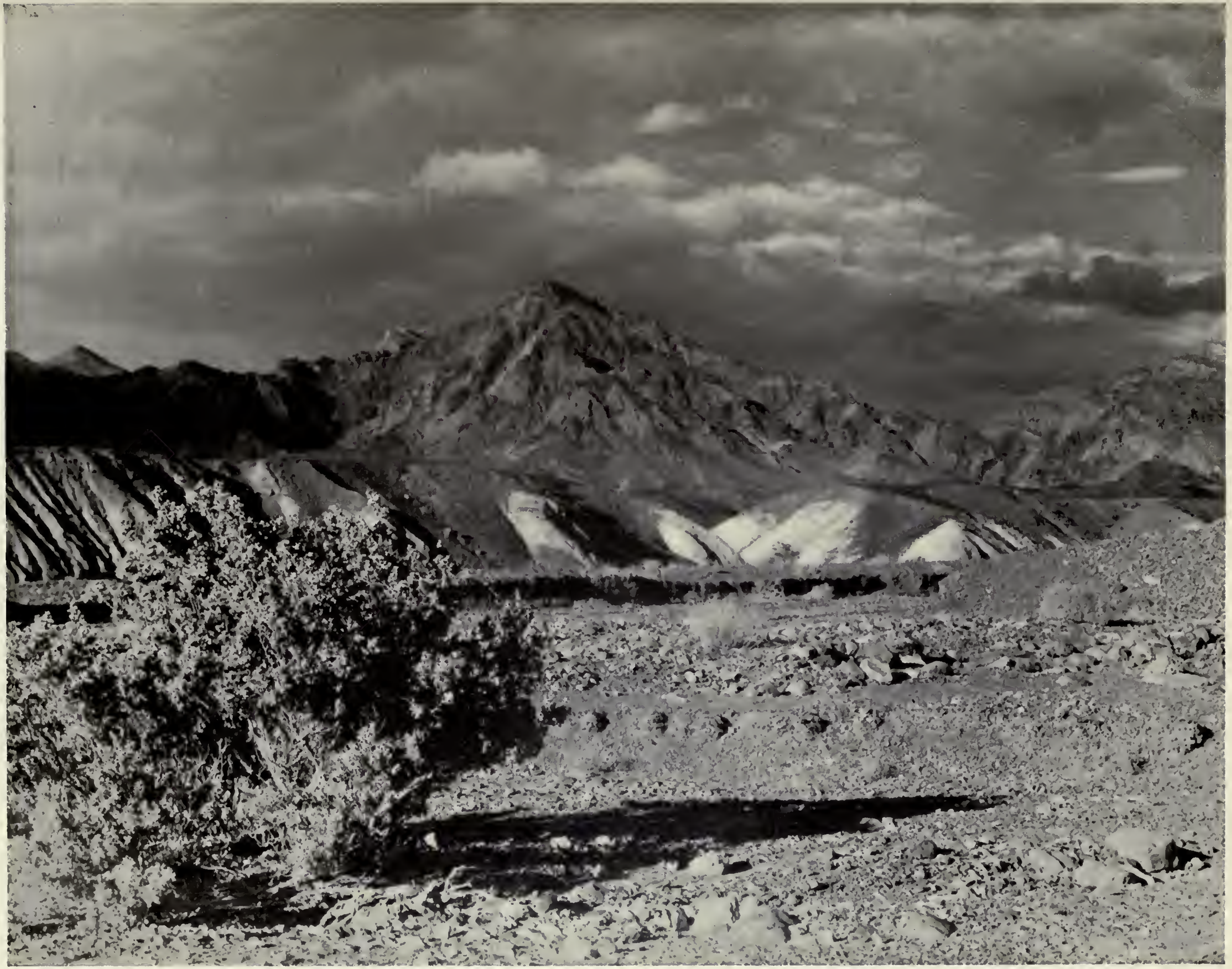
24. BEAVER TAIL, A SPINELESS CACTUS



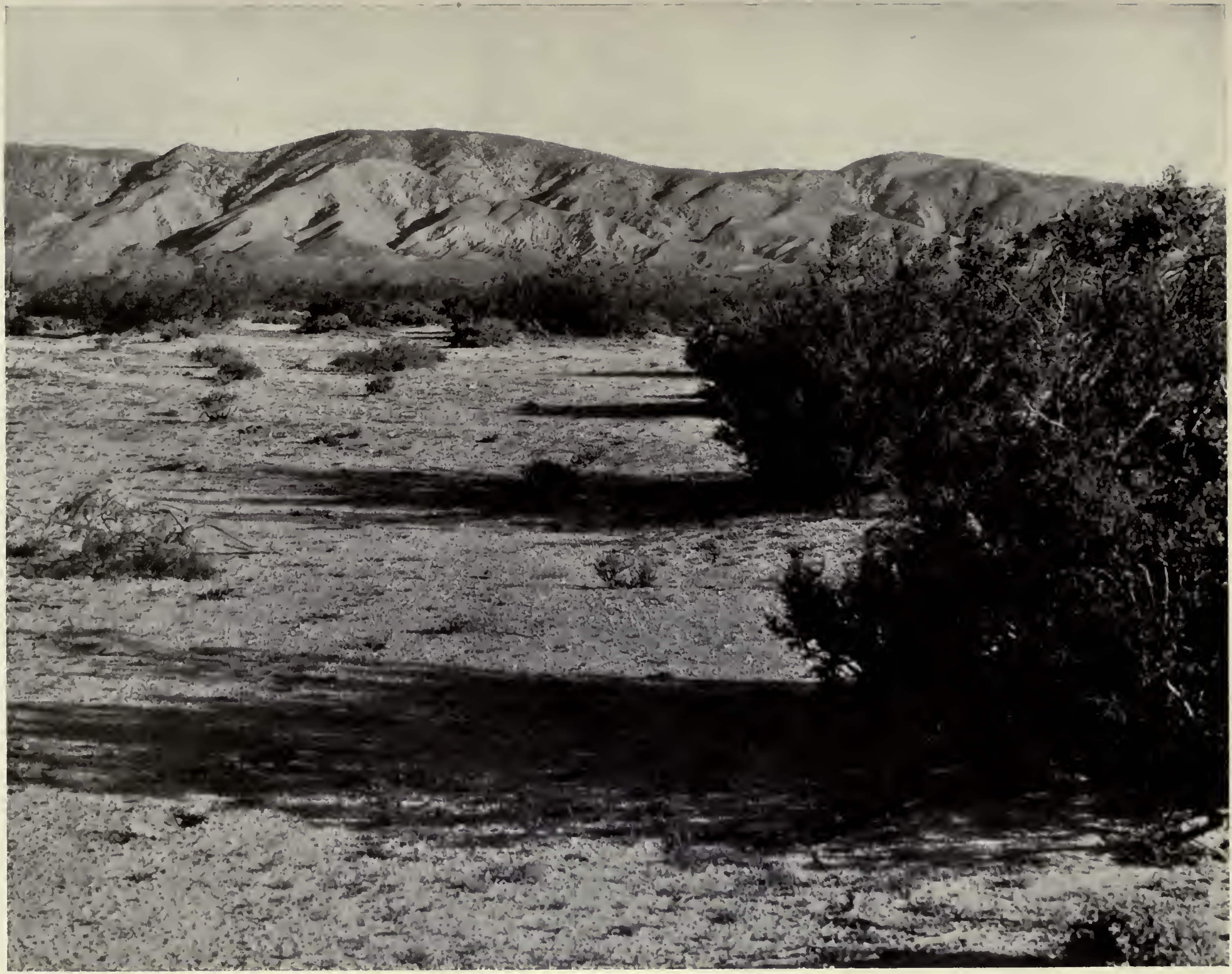
25. OCOTILLO



26. ENCELIA



27. DESERT HOLLY IN FURNACE CREEK WASH AT THE EDGE OF DEATH VALLEY



28. CREOSOTE BUSHES ON THE MOHAVE DESERT

regular spacing of Creosote Bushes over the desert sands. See how uniformly their shadows are cast in Illustration 28. "Like newly planted orchards," someone said.

The leaves of the Creosote Bush are evergreen, a beautiful dark green in color, and coated with a varnish of resin to protect against drying. It is the varnish of the leaves that gives to Creosote Bush its pungent and pleasant odor. It is this character, too, that provides the name "Greasewood" that most desert residents use. The green shrubs scattered over the dunes in Illustration 1 are Creosote.

The desert traveler soon learns to know and to love the Creosote Bush. Its pleasant odor, its welcome shade, its yellow blossoms, its sheer hardihood make it a permanent part of desert memories.

Joshua Tree (Illustration 29). Joshua Tree, the Tree Yucca (*Yucca brevifolia*), is the most famous tree of the Mohave, and the most interesting. It points its weird arms to heaven in an attitude of constant supplication. It is one of the few desert trees that occur in "forest" formation, and in places the open forests of this bizarre tree will extend for a hundred miles.

At the upper elevation of the Mohave, the Joshua Tree associates with the Desert Juniper (Illustration 7). The two make congenial but singular companions. One who climbs out of the desert up the bordering ranges on the south and west of the Mohave will be surprised to find the Joshua Tree climbing too, until the one-leaf Piñon Pines are reached. And desertward, the Joshua Tree goes down to the margin of the depressions where one meets the odor of the Creosote Bush.

Our first view of the Mohave Desert was over the Tehachapi Pass, between Bakersfield and the town of Mohave. We left the forest of the mountains and descended to the dry canyon through which roared the avalanche of water in the flood of the winter of 1932–1933. More and more barren became the slopes and the canyon floor, but otherwise nothing of interest showed. Gradually, however, we entered the realm of the Desert Juniper, and then turned another curve. Suddenly we all exclaimed in one breath, "Joshua Tree!" There it was, at the margin of the road, our first!

Desert Willows in a desert wash (Illustration 30). The desert washes, those sandy beds that spell the termination of the flood waters from desert mountains, are lined, like washes everywhere, with "willows." But the willows of the deserts are not true willows, they only look like willows. Really they are close relatives of the Empress Tree and the Catalpa. The Desert Willow, a catalpa of the desert, has taken the place of the true willows.

The Desert Willow (*Chilopsis linearis*) is a member of the Bignonia Family, and it is the only native member of this family in the Southwest. It makes up, in part, for the absence of other members of its family by lining the washes and the desert springs commonly from the eastern Mohave, throughout the Colorado and Sonoran Deserts, and east to Texas. Though it is a true native of the deserts and is equipped to endure intense sun and heat, it always grows where its long taproots may descend to a region where a permanent supply of water can be found.

Flowers, leaves and pod of Desert Willow (Illustration 31). One has only to look at the beautiful pink-lined trumpet blossoms of Desert Willow to realize that it is not a willow, but a next-door neighbor of Catalpa. The long pod reminds one, too, of catalpa pods. Only the long and slender leaves seem willowlike.

In April or May, sometimes even in late March, when the desert days begin to be so hot that all the landscape shimmers, one may find a Desert Willow in blossom. The desert is full of surprises. Desert Willow blossoms are one of them.

Desert Ironwood (Illustration 32). After the cactuses, the members of the Pea Family have taken the desert as their own. It is always an exceedingly great surprise to learn that the mesquites, the Cat's-claw, the Palo Verde, the

Smoke Tree, and the Desert Ironwood are close relatives of the garden pea. It is almost equally surprising to learn that these desert peas are shrubs or trees—trees of the desert! The pealike blossoms of most, and the pods of all, are proof of their pea relationships.

Desert Ironwood is one of the most impressive and one of the tallest of the trees of the desert. Its heavy limbs are often gnarled, twisted, and distorted. Its crown is broad and heavy. It may reach a height of twenty-five feet, an impressive height in a land of dwarfs.

Like the Desert Willow, the Desert Ironwood (*Olneya tesota*) solves its water problem by growing in the desert washes of the Colorado and Sonoran Deserts, and in Lower California. In the washes it sends a long taproot to the wet sands far below. Like all its near relatives, it is well supplied with thorns. Its pods, like those of the other desert "peas," supplied food for the desert Indians.

Smoke Tree (Illustration 33). Where the streams from the hills or mountains spread out in the wash that marks their end in the desert, there Smoke Tree (*Parosela spinosa*) presents its ash-gray cloud of fine branches. Like smoke it looks, at a distance, like a fixed foot of a desert dust devil or the thin cloud from a dying fire of brush.

The Smoke Tree has almost reached the point where it can live, like a cactus, without leaves at all. Leaves it does have, however, small leaves, for a short time in the late spring. In the late spring, too, it produces its pea blossoms of a violet-purple.

Smoke Tree may be found in the washes of the Colorado and Sonoran Deserts and in Lower California. It is another thorny, desert member of the pea family.

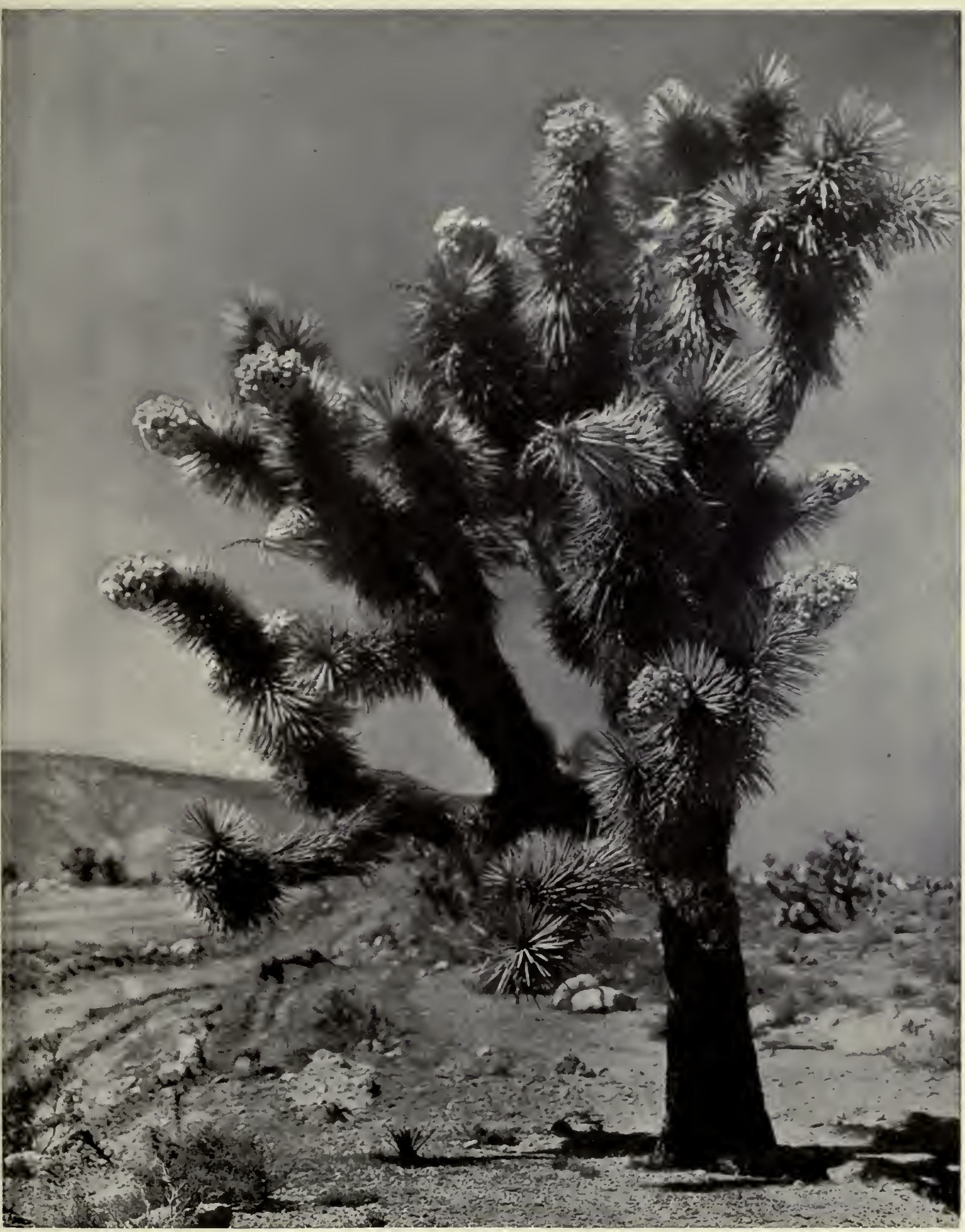
Palo Verde (Illustration 34). The early Spaniards called it "Palo Verde," meaning "Green Tree." Green it always is; lovely it always is; but not because of leaves or flowers. It has leaves, small leaves, for a few weeks only, in March. It has flowers, yellow and pealike, for a short period in April. Throughout the remainder of the year, Palo Verde still brings exclamations of delight because its numerous branches and branchlets weep in green luxury.

With the green in its stems, that is necessary for the making of food, Palo Verde has solved the big problem that accompanies leaves in the desert. Leaves have to be thick and coated with powdery scales or gum to last under the desert sun. Of course, if there are no leaves, something must take their place and present the green coloring to the light. Palo Verde solves it by having green branches, brightly green, throughout the year.

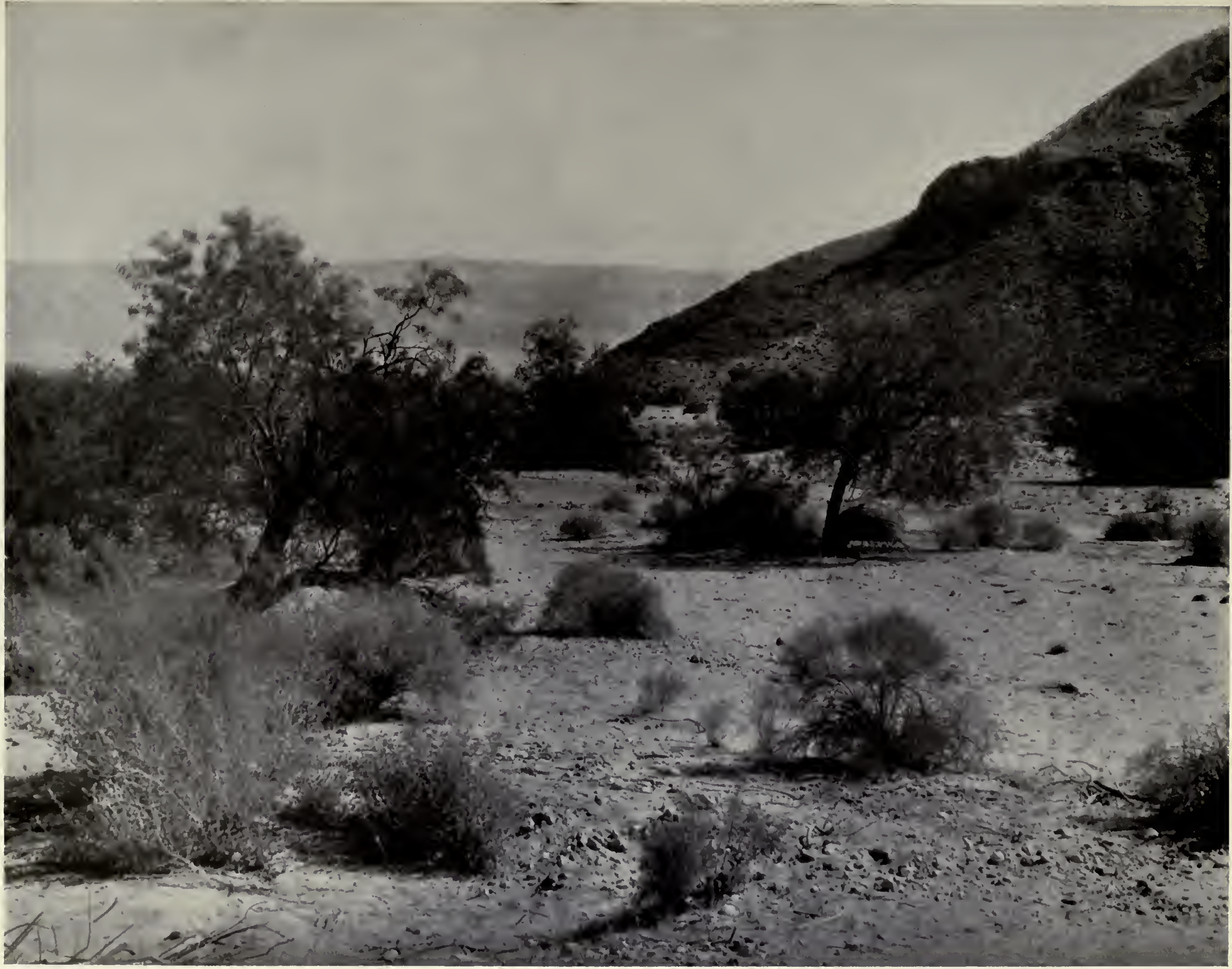
Palo Verde (*Cercidium torreyanum*) sometimes grows to a tree nearly twenty feet high, as, for instance, the one of the picture, and it keeps company with two fellow members of the pea family, the Smoke Tree and the Desert Ironwood, and lives in the desert washes of the Colorado and Sonoran Deserts, and in Lower California.

Washington Fan Palms in an oasis in the desert (Illustration 35). The Washington Fan Palm is a most distinctive feature of the Colorado Desert. Around the rim of the desert, in the San Jacinto, Santa Rosa, and Little San Bernardino Mountains, it marks the spots where the oases are. It grows just above the shore line of the old inland sea that once filled much of the Colorado Desert. It is the only palm native to California; and to California it is restricted.

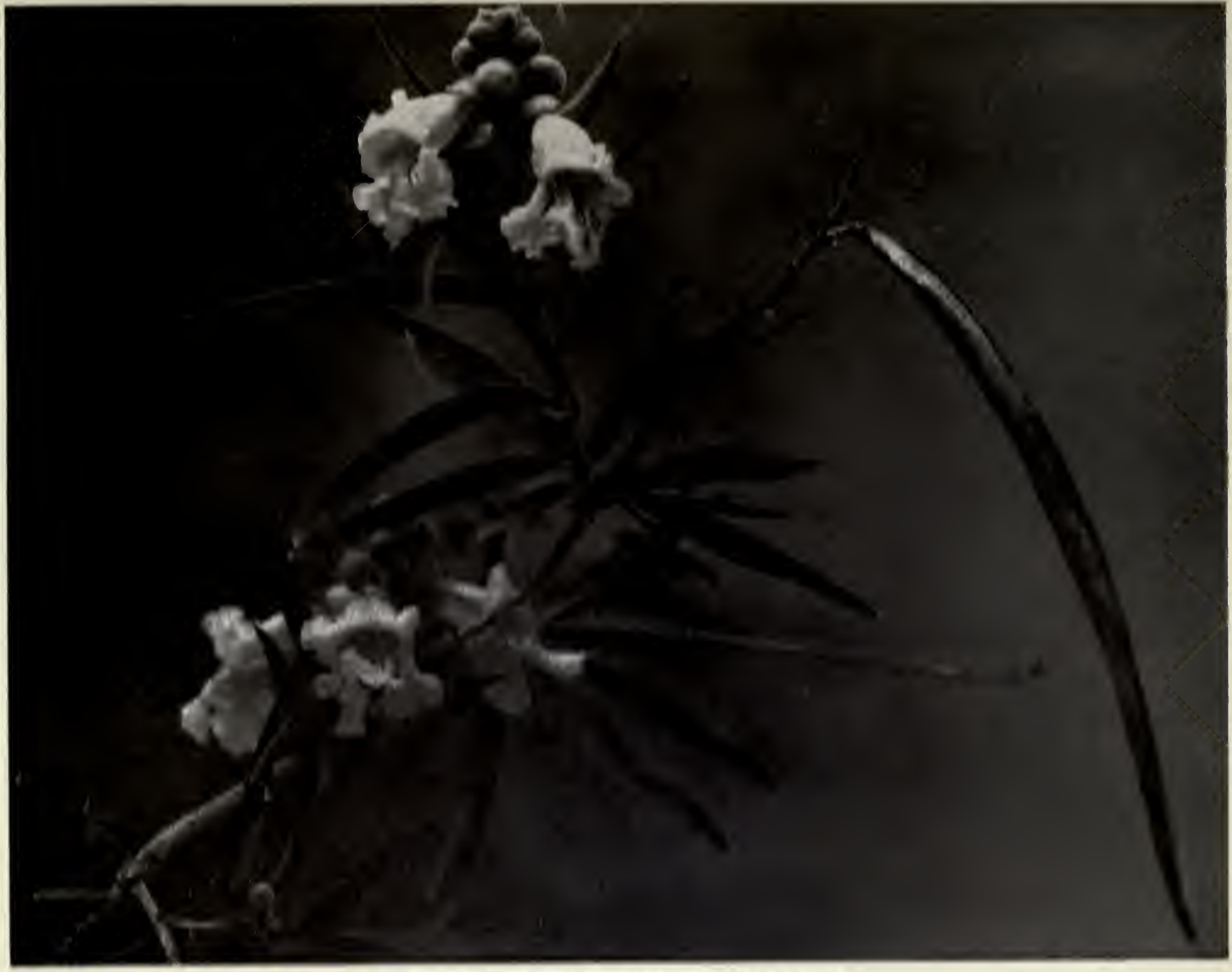
The Washington Fan Palm, or California Fan Palm (*Washingtonia filifera*), makes many of the names at the foot of the mountains of the Colorado Desert. Your travel map will list such places as "Three Palms," "Nine Palms," "Thousand Palms," and "Palm Canyon." To early white travelers the palm meant water, and sometimes life itself. To the desert Indians, the palm meant food and the material for huts. To the modern tourist, the palms mean an entrancing bit of desert contrast, for they grow where they can be water spendthrifts, though heated sands and desert mountain slopes, with water-pinching plants, surround them on all sides.



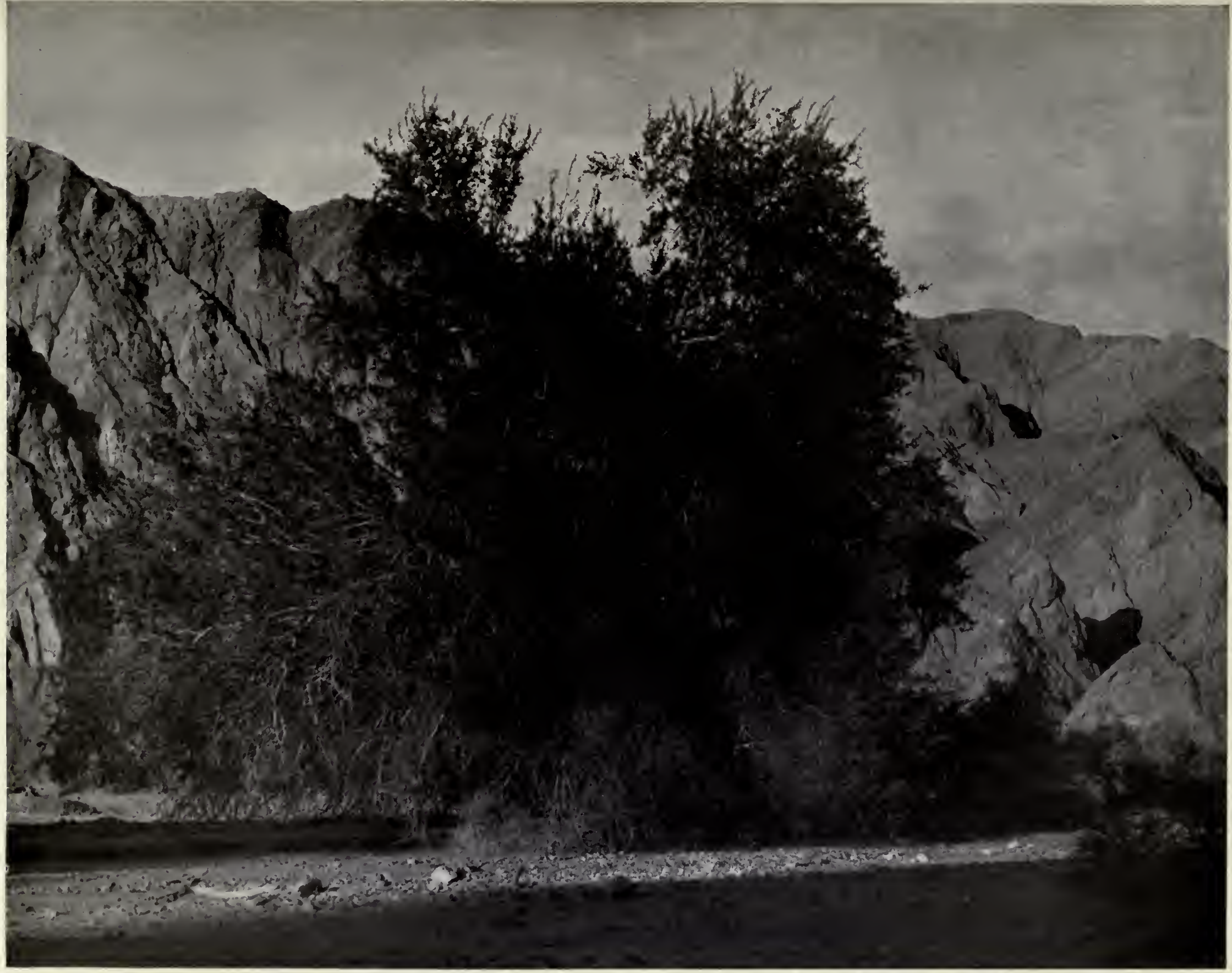
29. JOSHUA TREE



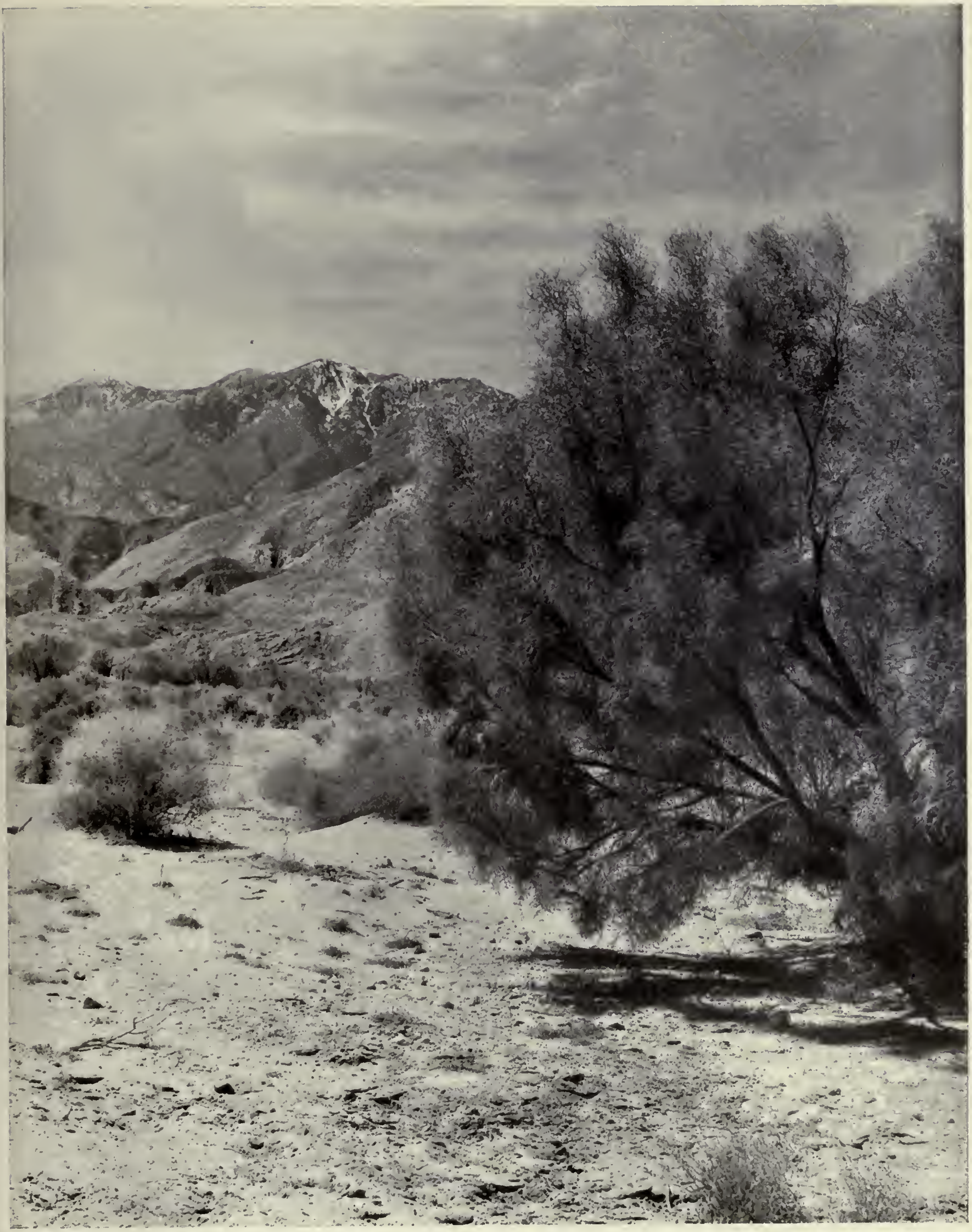
30. DESERT WILLOWS IN A DESERT WASH



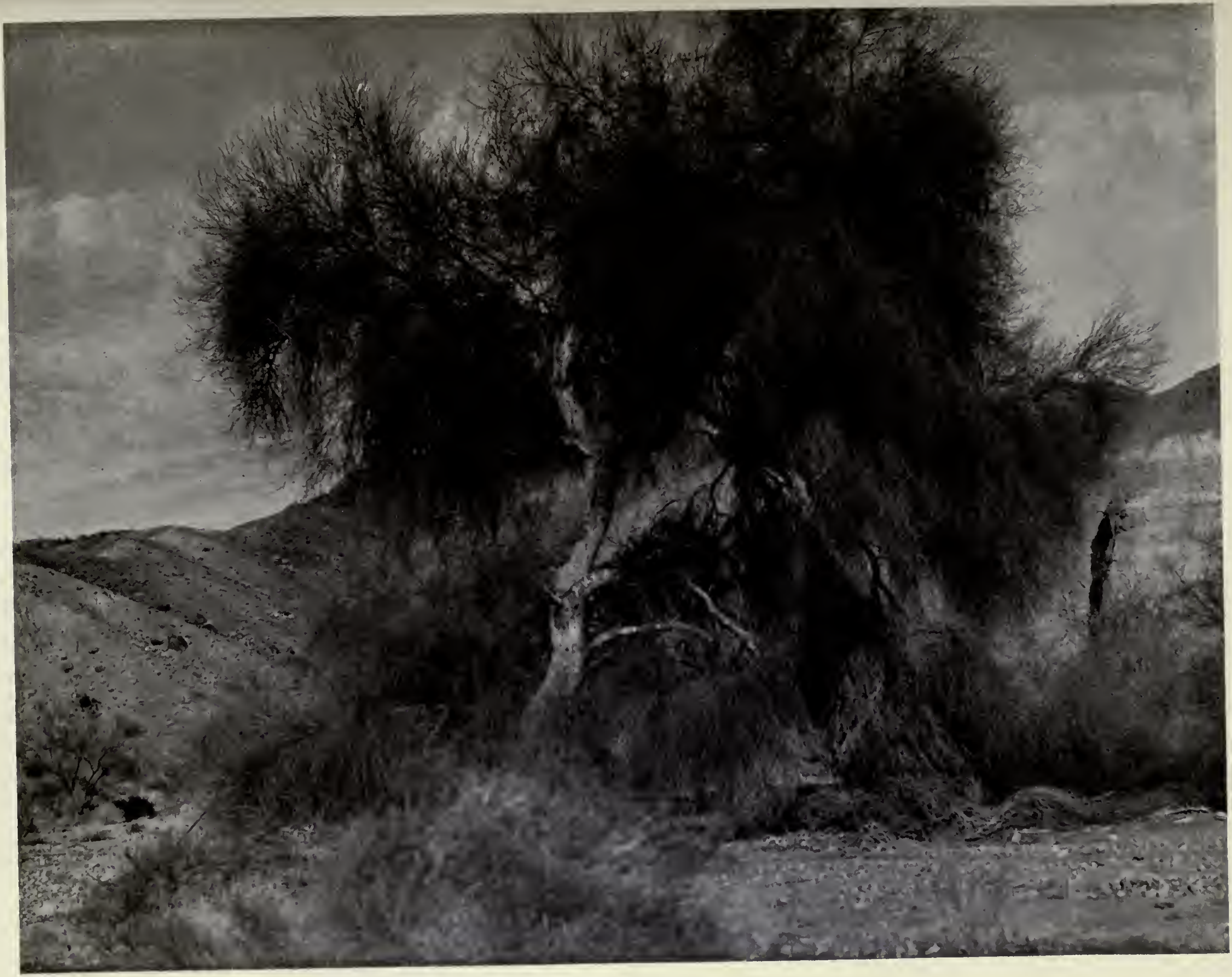
31. FLOWERS, LEAVES AND POD OF DESERT WILLOW



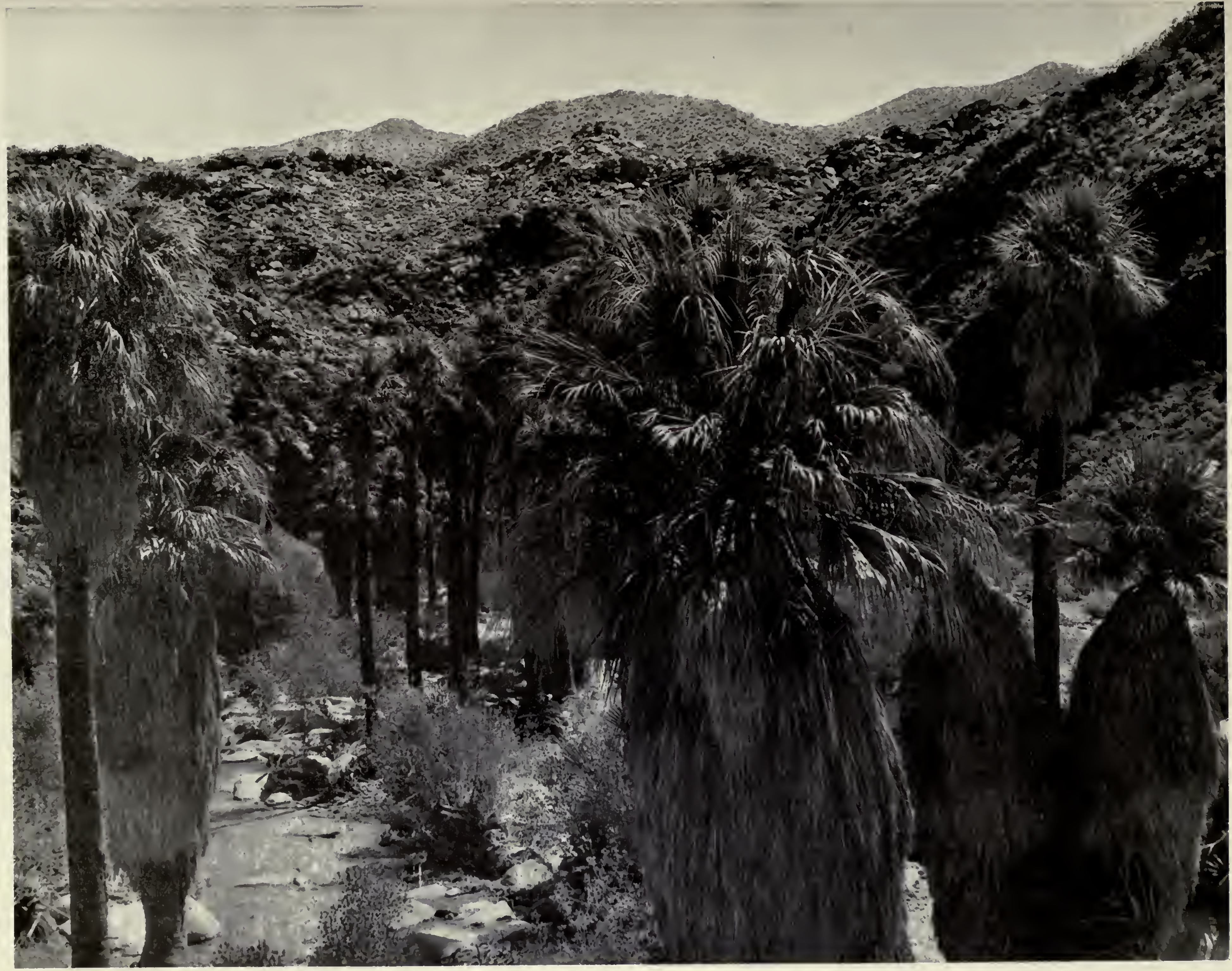
32. DESERT IRONWOOD



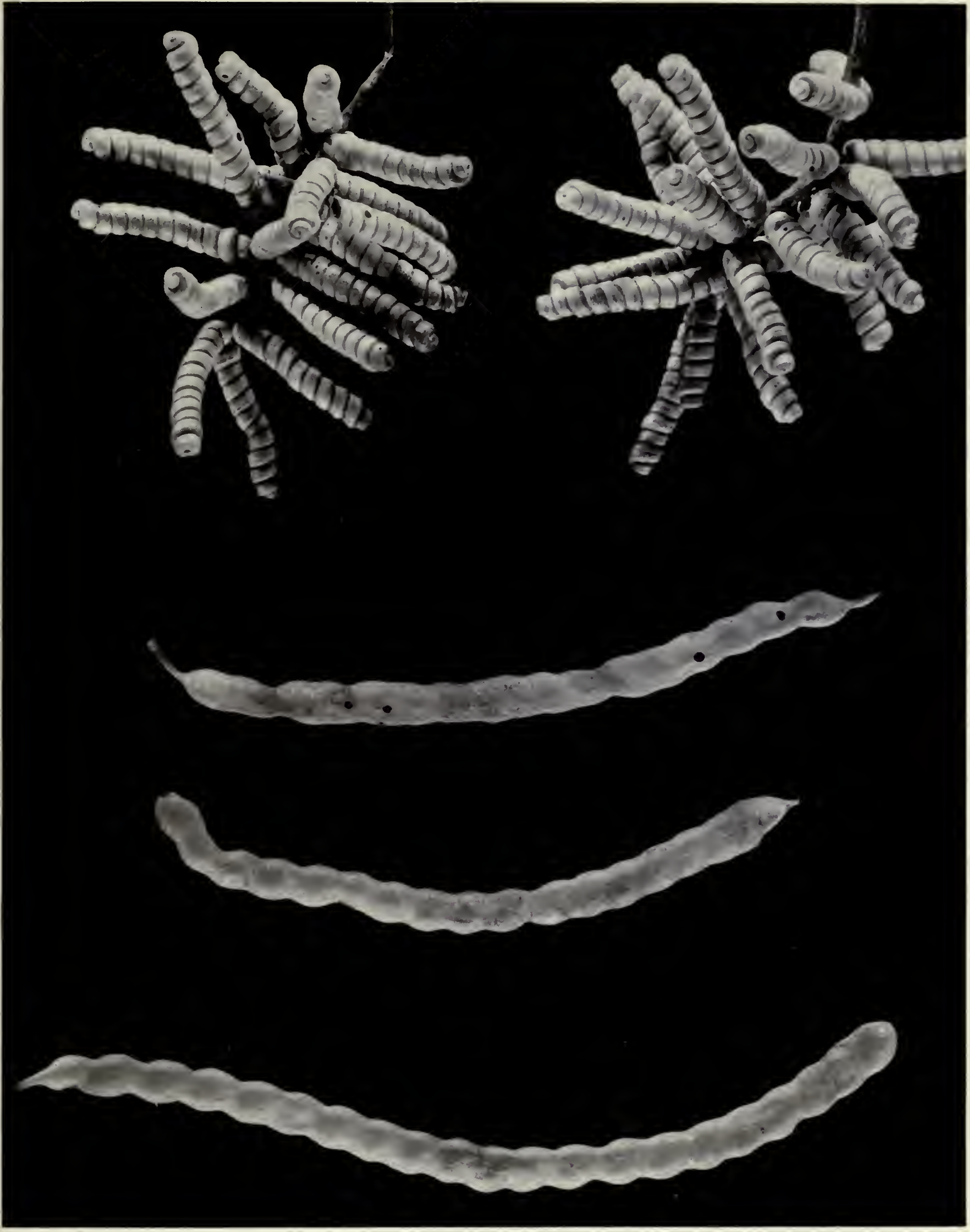
33. SMOKE TREE



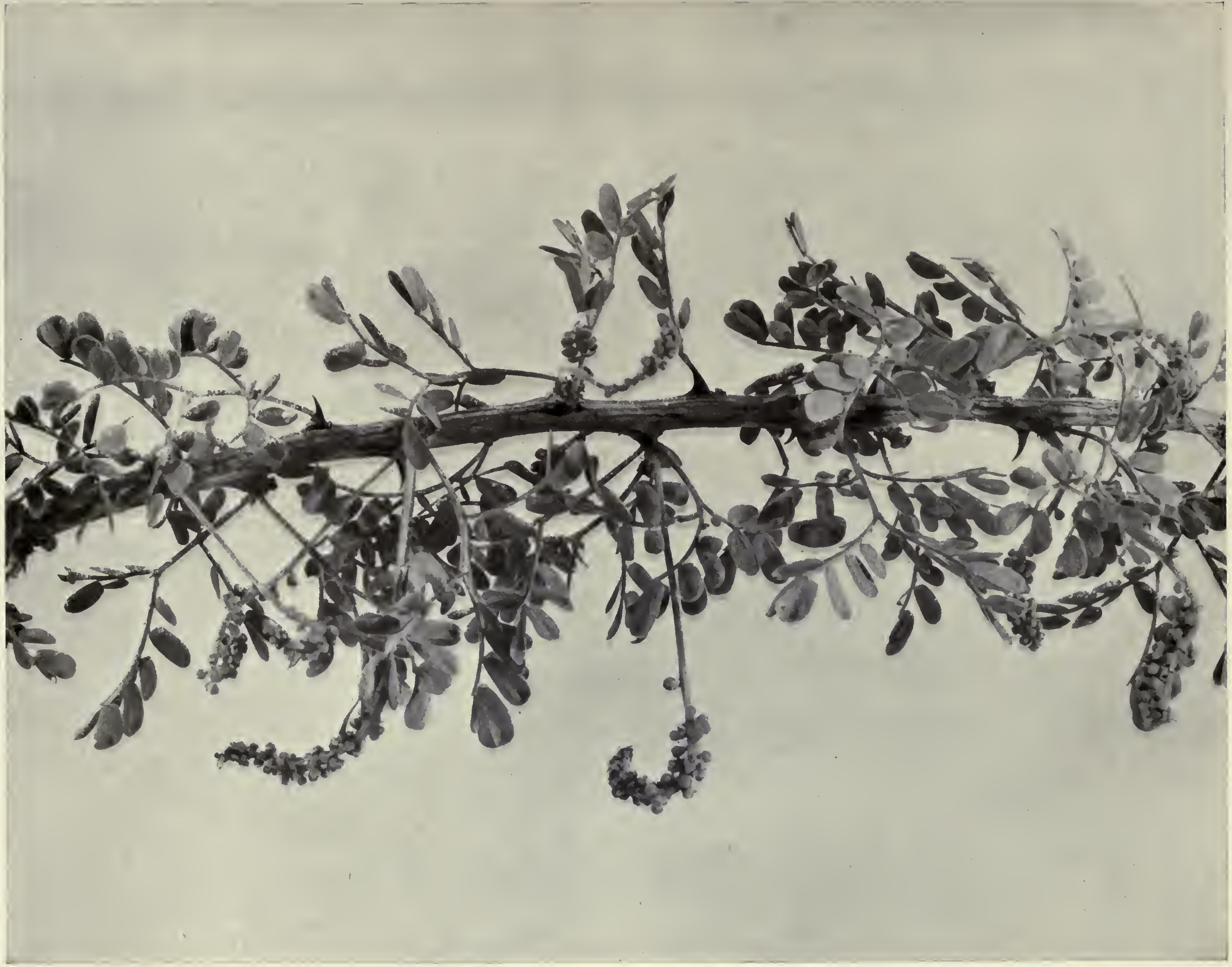
34. PALO VERDE



35. WASHINGTON FAN PALMS IN AN OASIS IN THE DESERT



36. PODS OF HONEY AND SCREW-BEAN MESQUITE



37. CAT'S-CLAW

The Washington Fan Palm, named for George Washington, has been lifted out of the desert and planted far and wide on California city streets and in parks. It can be seen commonly, nowadays, as far north as San Francisco Bay.

Pods of Honey and Screw-bean Mesquite (Illustration 36). "Mesquite" is a name with which the desert traveler conjures. The mesquites are the most widespread of the desert shrubs. The Honey Mesquite (*Prosopis juliflora*), it of the long, straight pods, is found in dry regions east to Texas, and as far south as northern Mexico. Screw-bean Mesquite (*Prosopis pubescens*), it of the pods in tight spirals, occurs in the Colorado and Mohave Deserts, north to Death Valley and east to New Mexico. Because the mesquites are so widespread, they furnished browse for early prospectors' burros, and fuel for the prospectors' fires. In the midst of a mesquite clump, if he could avoid the thorns that are a part of all desert shrubs, the prospector found shelter from desert "blows."

Mesquite clumps grow to heights of fifteen or more feet at the border of springs, or about streams, or on desert washes, where their long roots may reach a bountiful supply of water. On the desert sands, however, they rarely reach a height of more than three or four feet. Here, they hoist themselves into the air, fifty or more feet above the surrounding desert, by building up the mound on which they grow. The clumps elevate themselves by capturing the sand as it blows across the open spaces, and by constantly growing above it. Such sand mounds, with mesquite surrounding them, are conspicuous features of the Coachella Valley.

The mounds the mesquites build become also their mausoleums, for as the sand becomes deeper the lower levels of the plant die. The Indians and prospectors then find good, dried wood ready for their digging. At times, the fickle sand will blow away from part of the mound and scatter the dead wood of mesquite about its base.

Mesquite, like many of its desert shrub and tree companions, meets the trial of desert life by being deciduous, that is, by losing its brightly green leaves after a short period during the spring and early summer and then standing stark and leafless during the remainder of the year. The Honey Mesquites of Illustration 58 were still leafless when photographed in late March in the Coachella Valley. The mesquites, which cast their shadows onto the dunes of Illustration 1, were just coming into leaf in Death Valley in late March. That illustration shows scattered tops of dead but not completely buried mesquite. It is interesting that the Creosote Bushes do not catch the sand and build mounds, as shown in Illustration 1, perhaps because they do not grow in thickets as does mesquite.

The beans of the mesquite pods furnish food for desert Indians; for bean weevils, too, as one may judge from the holes in the pods of the picture. These two mesquites are two more members of the Pea Family.

Cat's-claw (Illustration 37). One must look closely to distinguish Cat's-claw from the mesquites, since its leaves and also its blossoms are very mesquitelike. When you brush against Cat's-claw on the desert trail, it will clutch at you. Mesquites may prick and scratch you, but Cat's-claw seizes and detains you. The thorns of the mesquite are straight, but the thorns of Cat's-claw are short and curved. They are the explanation for its name, as you may see by examining the stem in the picture. When you brush against these curved prickles, they say to you "wait a minute." A full minute you may wait before you have yourself entirely untangled.

Cat's-claw (*Acacia greggii*) keeps company with the mesquites, though it rarely grows so high. It is found throughout the Colorado Desert, north to the Providence Mountains in the Mohave Desert, east to western Texas, and south to Mexico. As you see by the scientific name, Cat's-claw is an acacia, and therefore in the same genus with the tribe of acacias that are so abundant on the South African deserts and in Australia. Cat's-claw, however, is the only acacia in the American deserts. It, and all acacias, are members of the Pea Family.

CHAPTER V

ANIMALS IN THE DESERTS

THE SURPRISE THAT comes from learning that there are many plants in the desert should prepare us for the fact that there are also many animals there. For one learns early that where plants occur there animals will exist also. It follows easily that where plants do not occur there will be no animals. Plants form the basis of food for all animals. Even though some animals may eat animals, still those eaten will have required plants for food.

But the deserts present problems for their animals just as for their plants. The greatest problem, as for plants, is that of water.

HOW THEY SOLVE THE WATER PROBLEM

Eaters of plants. Generally, the eaters of plants have no serious water problem, for they secure their water from the juices of the plants they eat. This applies to desert snails, which, when green plants are scarce, seal themselves in their shells with a mucous film until water comes again. This applies also to most of the desert plant-eating insects. It applies to such sluggish plant eaters among the lizards as the Crested Lizard, and the Chuckwalla. The Desert Tortoise gets its water thus and so do gnawers among the mammals, which may find succulent herbs.

But those eaters of such plant products as dry seeds or dead and dry wood have the most trying water problem of all and the most amazing method of solving it. These animals, such as the larvae of the Powder Post Beetle, the Big Desert Kangaroo Rat, the Desert Antelope Ground Squirrel, and perhaps the Mohave Pack Rat, use the water of metabolism.

To explain the water of metabolism it is necessary merely to point out that wood, or any plant or animal material, produces water when combined with oxygen and so burned. The burning gives up heat or heat energy, carbon dioxide, and water. Oxidation, or burning, goes on in the bodies of plants or animals at all times. It is the process whereby energy is released in the living body. Human beings eliminate most of the water that results from this burning that is going on constantly in their bodies, eliminate it through the skin, the kidneys, or the lungs. Man is a water spendthrift. The water that results from burning in the process of living is nearly all conserved by Powder Post Beetle Larvae, for there is no other water. Other "dry eaters" seek out succulent plants or at times may gnaw into the water storage of the Barrel Cactus; but they, too, can live for long periods on the water of metabolism.

Eaters of flesh. Animals that eat other animals let the victims solve their water problems for them. Thus, a Red Racer may swallow a Whiptail Lizard that is so hapless as to run into the Racer's burrow. The Racer at once is supplied with water from the juices of the Whiptail. The Whiptail, in its turn, had secured its water from insects. The insects had secured water from plants. The insects supplied water to one flesh eater, and this flesh eater supplied water to another flesh eater. Flesh eaters, thus, have an advantage in the solving of the water problem. Large flesh eaters, such as coyotes and foxes, are water spendthrifts, as are human beings, so they must go to water holes or desert streams from time to time.

DESERT ANIMAL EXAMPLES

From the sizable world of the deserts a few animal examples have been chosen for pictures and for stories. These range from snails through centipedes, scorpions, insects, toads, lizards (several of them, since they are most abundant in the deserts), snakes, turtles, birds, to mammals. Such a list seems large, but it is complete only in that it gives an idea of the great range of life that exists in a world as inhospitable as that of the deserts. The arrangement followed is merely that of simple animals to the more complex, from snails to mammals.

The "Little Shells" in the desert sands of the Coachella Valley (Illustration 38). The Coachella Valley has been an inland sea that alternately filled with the waters from the Colorado River and dried down to a salty sink as the fickle river changed its coarse and flowed into the Gulf of Lower California. During the days when water stood where desert now is, multitudes of small snails thrived in the shallow water. Now the water is gone, but the drifting sand uncovers the empty shells of the snails of another day.

The citizens of the Coachella Valley tell us that the word "coachella" means "little shells." There is no proper explanation for the word "coachella" unless it has been corrupted from the Spanish word "conchiella" which is the correct name for "little shells." Perhaps, through the years since the early Spaniards first named this desert from its shells, the word "conchiella" has been corrupted by some agency to "coachella."

In any case, "little shells" is a picturesque and romantic name for this part of the Colorado Desert. "Little Shells" that carried life years ago when water played where now blows the desert sand.

Centipede, with enlarged view of poison fangs (Illustration 39). You must turn rocks or fallen debris on the desert mountains to find a centipede —it will never find you. As a matter of fact, centipedes are peculiarly uninterested in mankind, and under no circumstances do they poison human beings unless the human is determined to search them out and pick them up. Centipedes, however, are traditional creatures of the desert, and so one is shown here.

Centipedes are not restricted to the deserts, though the largest do occur there. The one of the picture is nearly natural size. It came from the Colorado Desert. This centipede was as valiant as any of its kind. It seized the largest of insects and tarantulas and quickly poisoned and consumed them. Such things constitute the normal centipede food.

Centipedes are exceedingly well supplied with legs, as you may see. There are less than a hundred, though, in spite of the name "centipede," which means "a hundred feet." You can prove that by counting them. The first pair of legs are very thick and heavy, and are used as the poison fangs. The enlarged view shows the undersurface of the head end of the centipede. The poison fangs are the conspicuous hooks just below the mouth. The ability of centipedes to poison human beings has been greatly exaggerated, as has the poisonous ability of scorpions and many other desert inhabitants.

Scorpion (Illustration 40). Scorpions, like centipedes, are not restricted to the deserts, though those of the United States reach their largest size there. Because of their large size, the desert scorpions are also a tradition of the desert, and so the scorpion takes its place with the centipede.

Scorpions, like centipedes, spend the daytime hidden beneath rocks, or in crevices, or under various types of debris, usually in the damper places of the desert. Their "sting" is the point at the end of the poison sac at the tip of the "tail." The scorpion of the picture, which is only slightly enlarged, has its "sting" curled over its back, ready for action. When the "sting" goes into action it swings forward, fast as a finger flick. Since the scorpion, with its "pinchers" widely spread, always faces its foe, its "sting" must reach over its back and *beyond* its head.

Work of Powder Post Beetles in Desert Ironwood (Illustration 41). One day, in getting acquainted with the desert at the north end of Salton Sea, we came near a pile of Desert Ironwood drift. There was nothing unusual to be seen in the pile at first glance, so it was nearly passed by. A sound like crackling flames stopped us, however, and we glanced back. There was no fire in the drift; the noise must have come from something else. Close inspection showed little rows of brown powder beneath each branch and log. A still closer view showed numerous holes in the wood. The crackling fire was explained. It was the noise made by the jaws of the young, or larvae, of the Powder Post Beetle, eating wood!

The wood of desert trees is extremely hard, but Powder Post Beetles attack it and reduce all but the outside shell to powder. Every pile of firewood will be attacked, and a noise like fire will come from the pile long before it reaches a stove.

The beetle larvae live in the dry wood in the desert, because in their eating they are able to use the water of metabolism.

Life history of Powder Post Beetle (Illustration 42). We collected a chunk of wood from the pile of Desert Ironwood near Salton Sea. Whenever we listened intently we could hear the noise like crackling fire—the jaws of the Powder Post Beetle young were still chewing away. At home we set the little log on a sheet of black paper and in a few days we had a nice pile of powder beneath each hole. This we photographed. After that the log was split open and a full life history of the beetle collected.

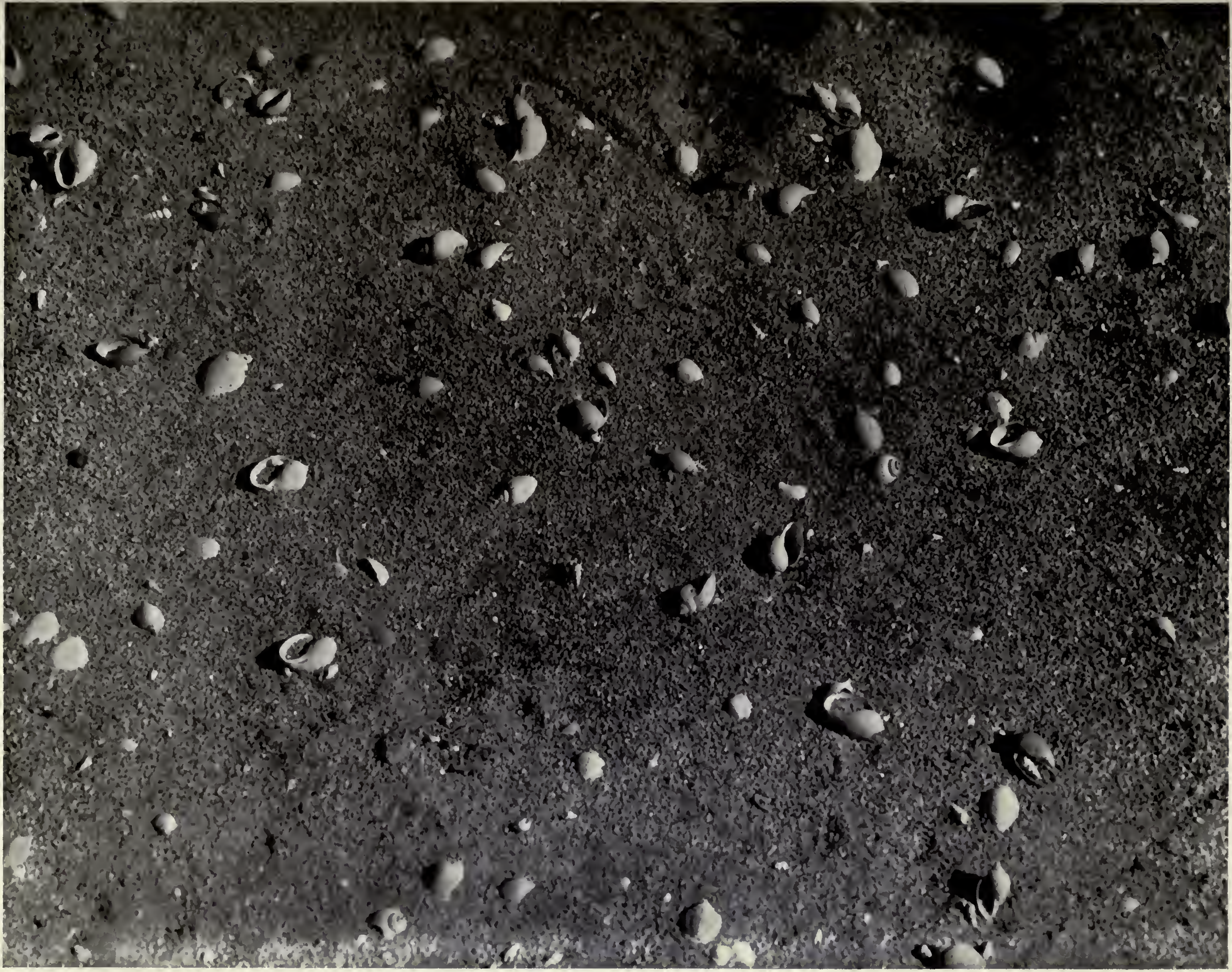
At the left, in the picture, is the grub, or larva. This is the important eating stage in the life of the beetle. This is the stage that makes the noise, like a fire. In the center is the pupa. The pupa is a quiet stage, a stage in which no eating is done. It is the work of the pupa to make the larva over into the grown-up beetle. The pupa shows the cases in which legs, antennae, and wings of the adult beetle will grow. On the right is the adult Powder Post Beetle. It has its head turned under in a fashion peculiar to the Powder Post Beetles of the family Bostrichidae, of which it is a member.

In the illustration the beetles are about two and one-half times as large as they are in life.

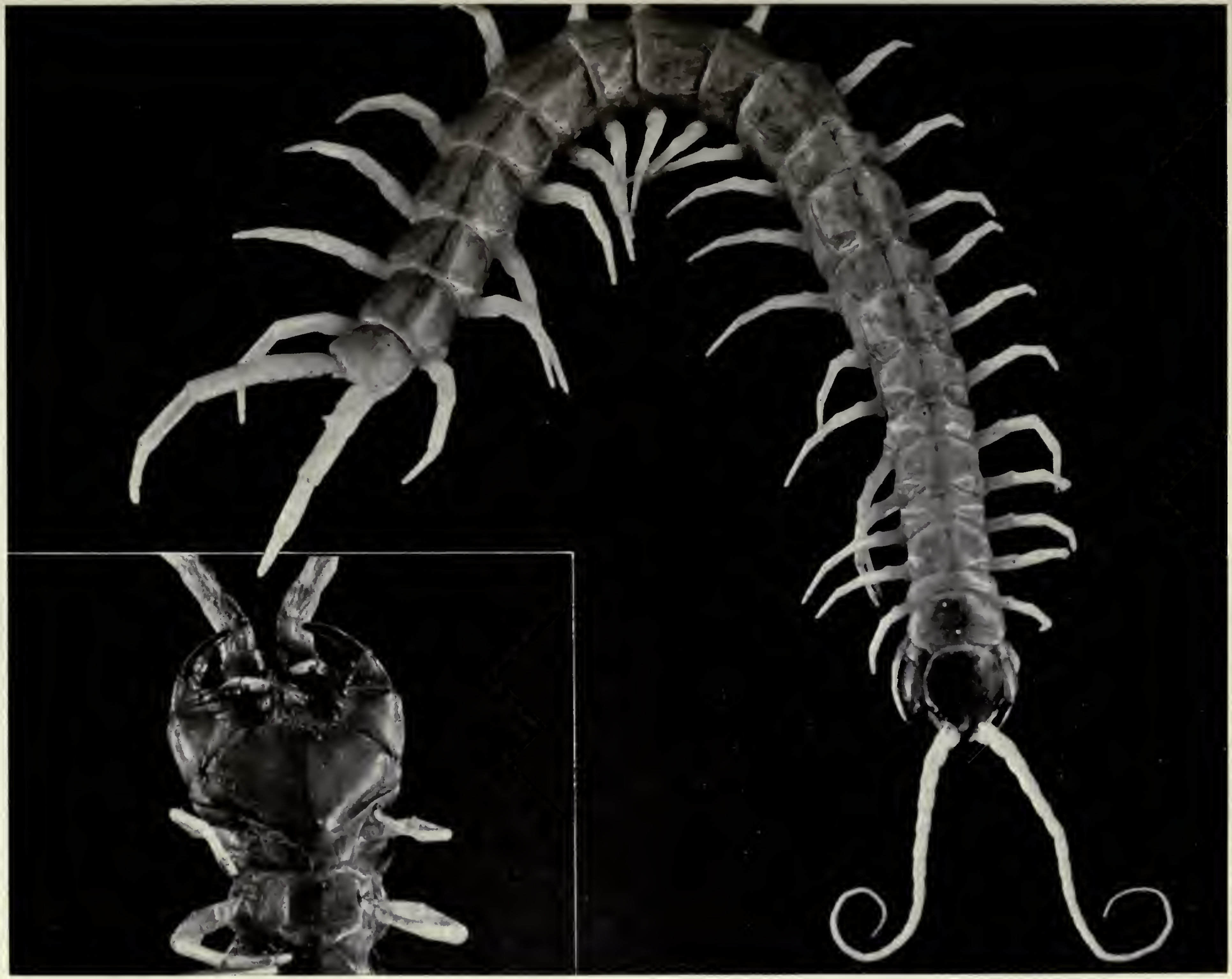
Desert Tree Toad on a granite boulder (Illustration 43). Since water is so scarce in the desert, it would seem to be no proper place for a frog, or even a toad. As a matter of fact, toads and frogs are not very abundant in the deserts, but they do occur wherever there is permanent water. One of the most interesting of these is the Desert Tree Toad (*Hyla arenicolor*)

Anyone who has lived in the West has heard, in the spring, the "shirk-it, shirk-it" of the Pacific Tree Toad that occurs almost everywhere. The Pacific Tree Toad says "shirk-it" in the deserts too. We had never heard the voice of the Desert Tree Toad, which lives in the desert near the lower ends of the mountain streams, so we went on a hunt one night under the desert stars.

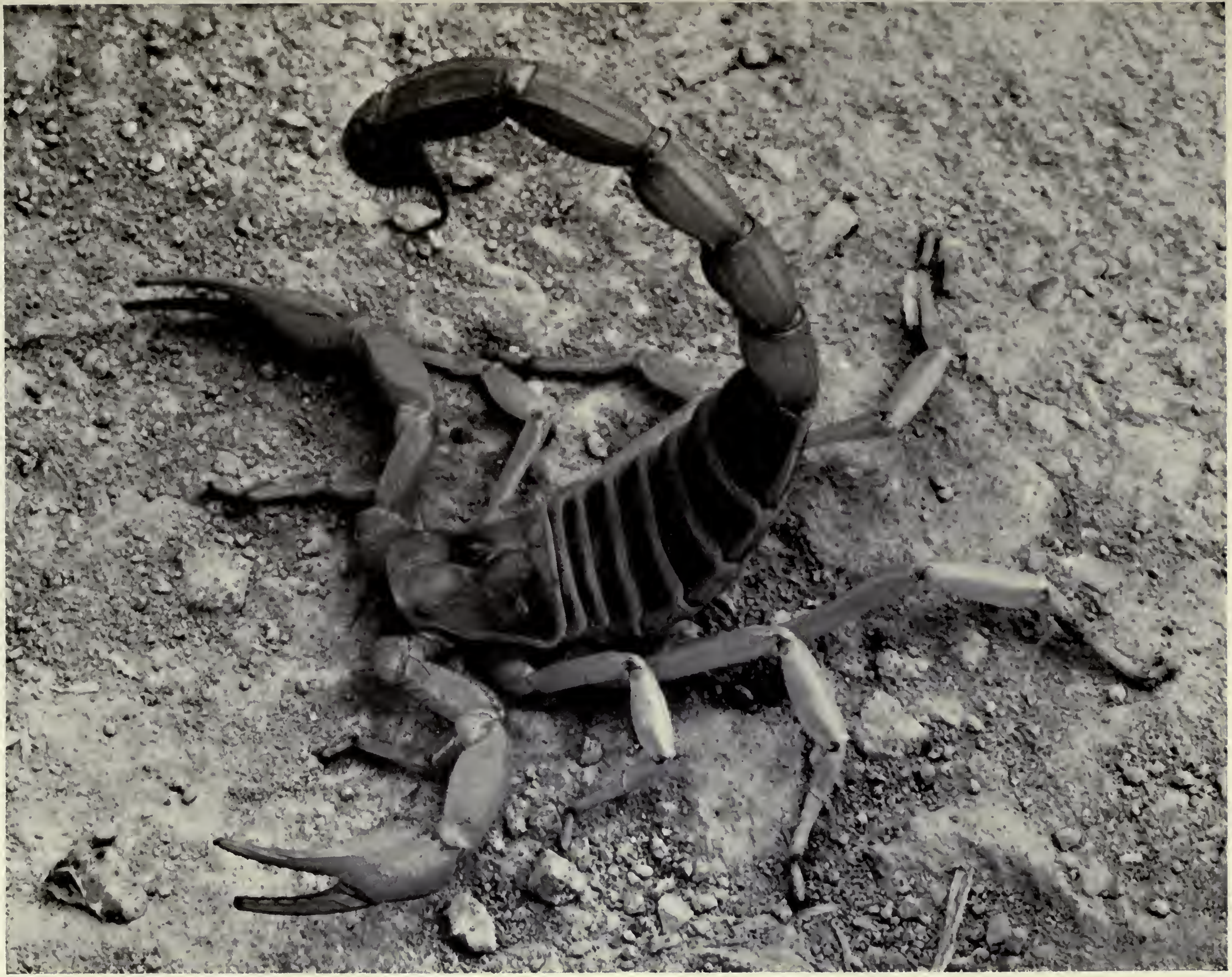
Did you ever see the desert sky at night? Well, that's another thing, but it was a thrill that almost equaled the voice of the Desert Tree Toad. We finally found him, or rather heard him, in a bit of shallow water of the Tahquitz Creek, that comes down from Tahquitz Peak, near Palm Springs in the Coachella Valley. We knew it was our Desert Tree Toad, for there was a voice saying "quack, quack," like a duck, and no other frog or toad ever says "quack." Pretty soon we saw



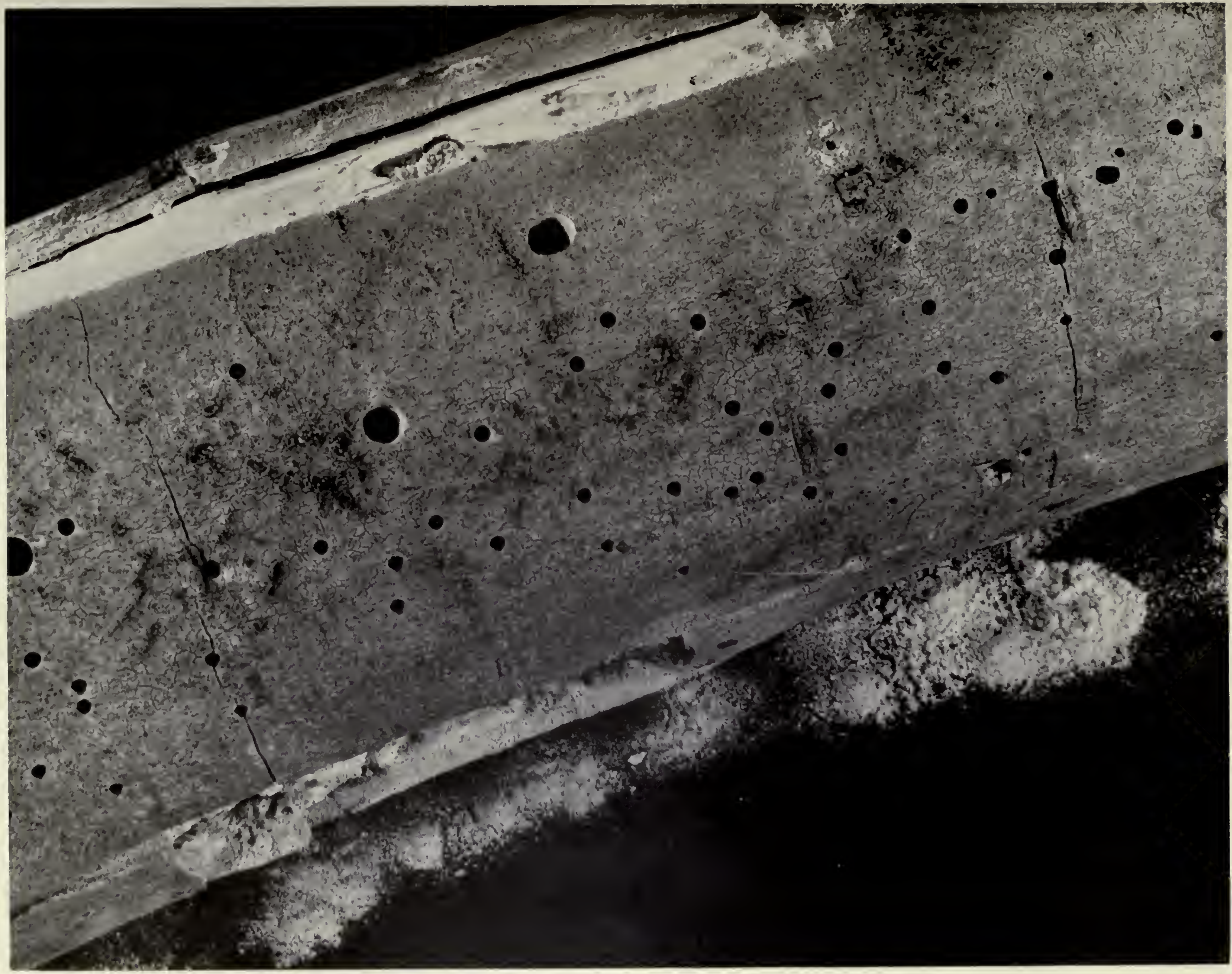
38. THE "LITTLE SHELLS" IN THE DESERT SANDS OF THE COACHELLA VALLEY



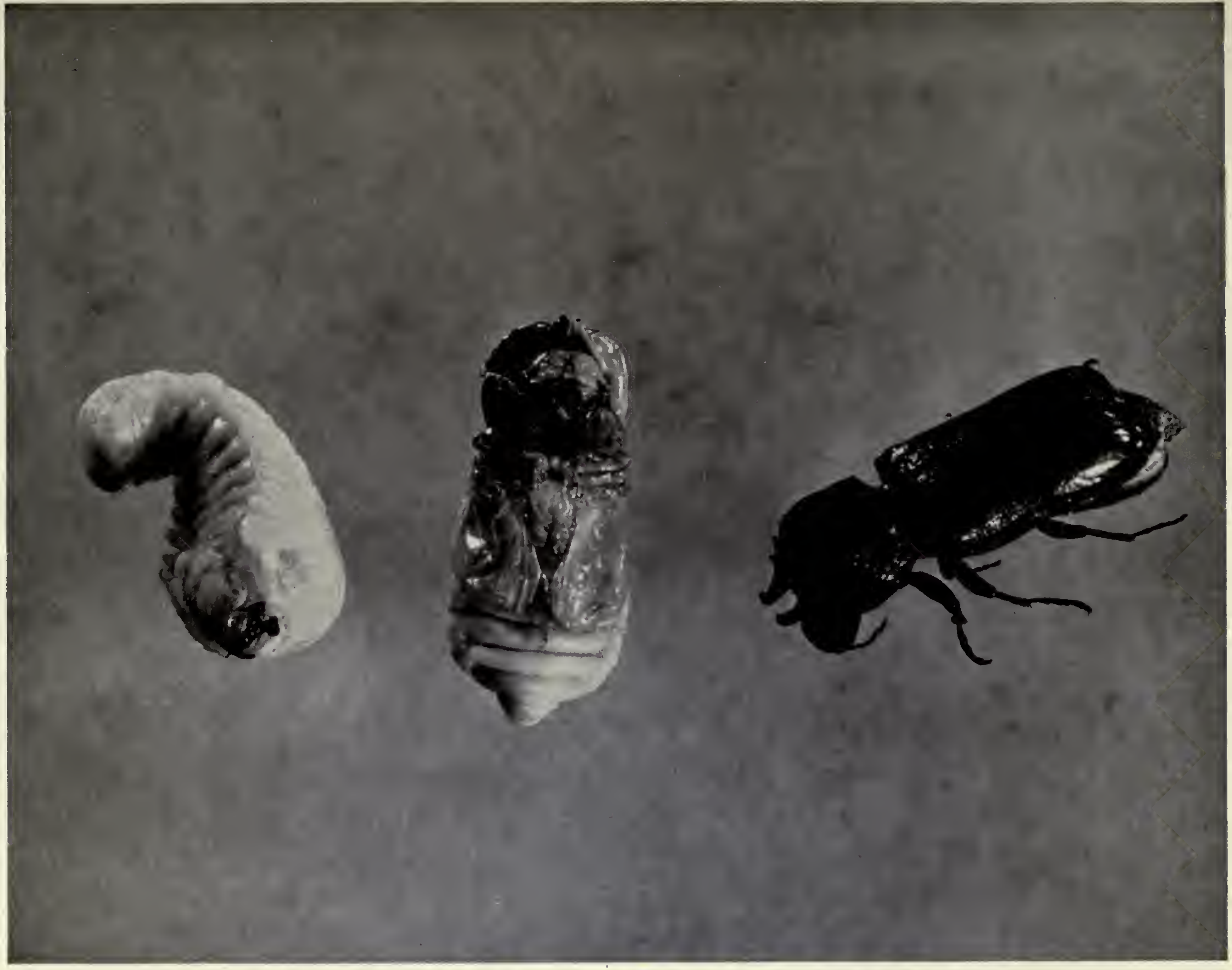
39. CENTIPEDE, WITH ENLARGED VIEW OF POISON FANGS



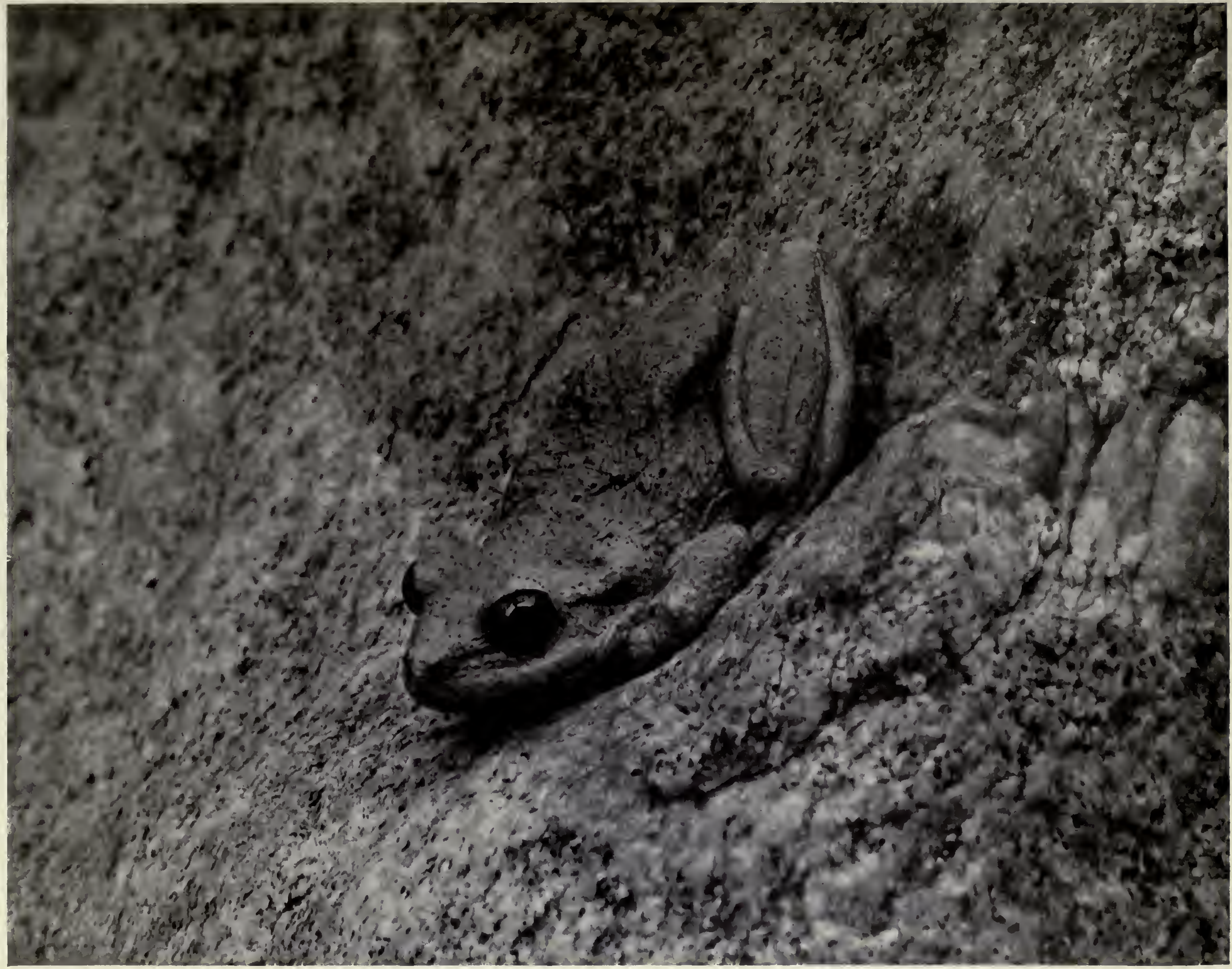
40. SCORPION



41. WORK OF POWDER POST BEETLES IN DESERT IRONWOOD



42. LIFE HISTORY OF POWDER POST BEETLE



43. DESERT TREE TOAD ON A GRANITE BOULDER

him, with his drum all blown up beneath his chin.

Later we learned that Desert Tree Toads are so much a part of the desert that they sit on granite rocks, at the side of their home puddle or creek, and often they are in the hot sun. When on the rock, their coloration makes them seem a part of it, and thus they are protected from their enemies.

This little toad is not much larger than the end of a good-sized thumb.

Brown-shouldered Lizards of the desert (Illustration 44). These prettiest little lizards of the dry and hot regions are also the most abundant. They are not restricted to the deserts, though they are exceedingly common there, but occur from the Pacific Ocean east to Utah, north nearly the full length of the San Joaquin-Sacramento Valley, and south into Lower California and Mexico. They can be expected to scurry into rock crevices, rodent burrows, beneath stones or under bushes wherever open areas of dry ground or sand have given them sunny spots on which to stalk their food. So abundant are they on the Mohave Desert that we, in searching for new and different lizards, became quite disgusted to find that three-fourths of our captures were these.

These lovely little lizards are variable in markings, but they are always banded with longitudinal stripes of brown and white; stripes that may be broken up into many different forms of blotches, or spots, or crescents. In the sun, the dainty lizards sparkle with a metallic luster of purple and blue. They are called "brown-shouldered" because of a spot of brown a little larger than the others, at the region of the shoulder.

The Brown-shouldered Lizards (*Uta stansburiana*) feed upon insects. The insects are captured by a stealthy stalking, and a final dash. The insects supply the moisture necessary for a life in regions that are dry.

Enemies of the Brown-shouldered Lizard are many. Shrikes pounce upon them and pin them up on a thorn of a desert shrub. Larger lizards and snakes of the desert devour them greedily. The Brown-shouldered Lizard has two means of defense: he may leave his squirming tail with the enemy while the remainder of him gets away; or he may be too swift to be caught in the first place. If the tail has been lost, a new one is grown to replace it.

The lizards in the picture are nearly natural size.

Desert Night Lizards (Illustration 45). Since one is inclined to think of lizards as creatures of the light and sun, it is something of a surprise to learn that a few species of lizards are creatures of the night, never seen in the open during the day. It was because of this feeling, perhaps, that scientists considered the Desert Night Lizard (*Xantusia vigilis*) rare until rather recently. Though the first Desert Night Lizard was collected and named nearly eighty years ago, many years passed before it was learned that almost every fallen branch and pile of leaf debris beneath the Joshua Trees concealed one or more of these short-legged residents of the desert.

We, too, had made a trip to the Mohave before we learned the secret of the Desert Night Lizard. On our second journey, though, we began searching beneath the first Joshua Tree in the edge of the Mohave. Almost at once we found a specimen. After that it became a game, and we found Desert Night Lizards in numbers far and wide over the Mohave, wherever Joshua Trees were growing.

It is believed that the Desert Night Lizard requires as food the termites, or white ants, that are so abundant in fallen limbs of the Joshua Tree. This lizard does not seem to eat any other food. This food requirement has made Joshua Trees and Desert Night Lizards permanent associates. The desert has no more interesting story of animal and plant relationship.

This lizard produces its young in an interesting fashion, too, for the eggs, instead of being laid as is the process with most lizards, hatch in the body of the mother.

The lizards of the picture are just a little larger than natural size.

Gridiron-tailed Lizard (Illustration 46). The Desert Gridiron-tailed Lizard waits in bright-eyed alertness in the shade of a shrub until you approach too near, then it curls its brilliant tail over its back and goes so fast that it appears to leave its shadow behind. And when it stops at the edge of a Creosote Bush it disappears, for the sand coloring of its back make it a part of the sand. Even the black stripings of the upper side of the tail are no aid in its discovery, for they appear merely as shadow markings made by twigs of Creosote Bush.

There is no more attractive animation in the sandy parts of the deserts than the Desert Gridiron-tailed Lizard. It is one of the most abundant bits of life there. If you want to match your wits with a creature that will try them to the limit, attempt to catch a Gridiron-tailed Lizard. You probably will never do it unless you become expert with a "lizard snatcher," a little slip noose of thread at the end of a pole. When you have raced, cautiously advanced, frequently missed, and copiously sweated you may get one. Turn the lizard over then and marvel at the white underparts brilliantly marked with blue, black, and yellow. It will "play dead" for you if held for a moment on its back.

The Gridiron-tailed Lizard spends the day on the hot sands capturing insects, which seem to make up most of its food. At night it folds its front legs along its sides and pushes itself into the sand by vigorous body wriggles and shoves from the hind legs.

The Desert Gridiron-tailed Lizard (*Callisaurus ventralis*) may be found commonly on the sandy portions of the deserts of California, southern Nevada, Arizona, and Lower California. The picture shows it about natural size.

Crested Lizard (Illustration 47). We saw our first Crested Lizard (*Dipsosaurus dorsalis*) on the sand in a clump of Creosote Bush on a wash in the San Jacinto Mountains on the south margin of the Coachella Valley. Compared with the swift Desert Gridiron-tailed Lizard, this fellow seemed slow. We set about to capture him, for our camera craved material; but in vain. The lizard seemed always just beyond our reach. At times he stood quietly under the Creosote and watched us with curious eye. When the hand all but closed over him, off he ran. At last he went down a rodent burrow and we gave up the chase. The next year we returned with a proper "lizard snatcher," and within a hundred feet of our first Crested Lizard we saw another, or perhaps it was the same one. The "snatcher" caught this Crested Lizard; and it posed for the picture that you see. It was photographed on the sand, not more than fifty feet from the place of its capture. After the picture was taken, we let it go. We expect to see it again, someday.

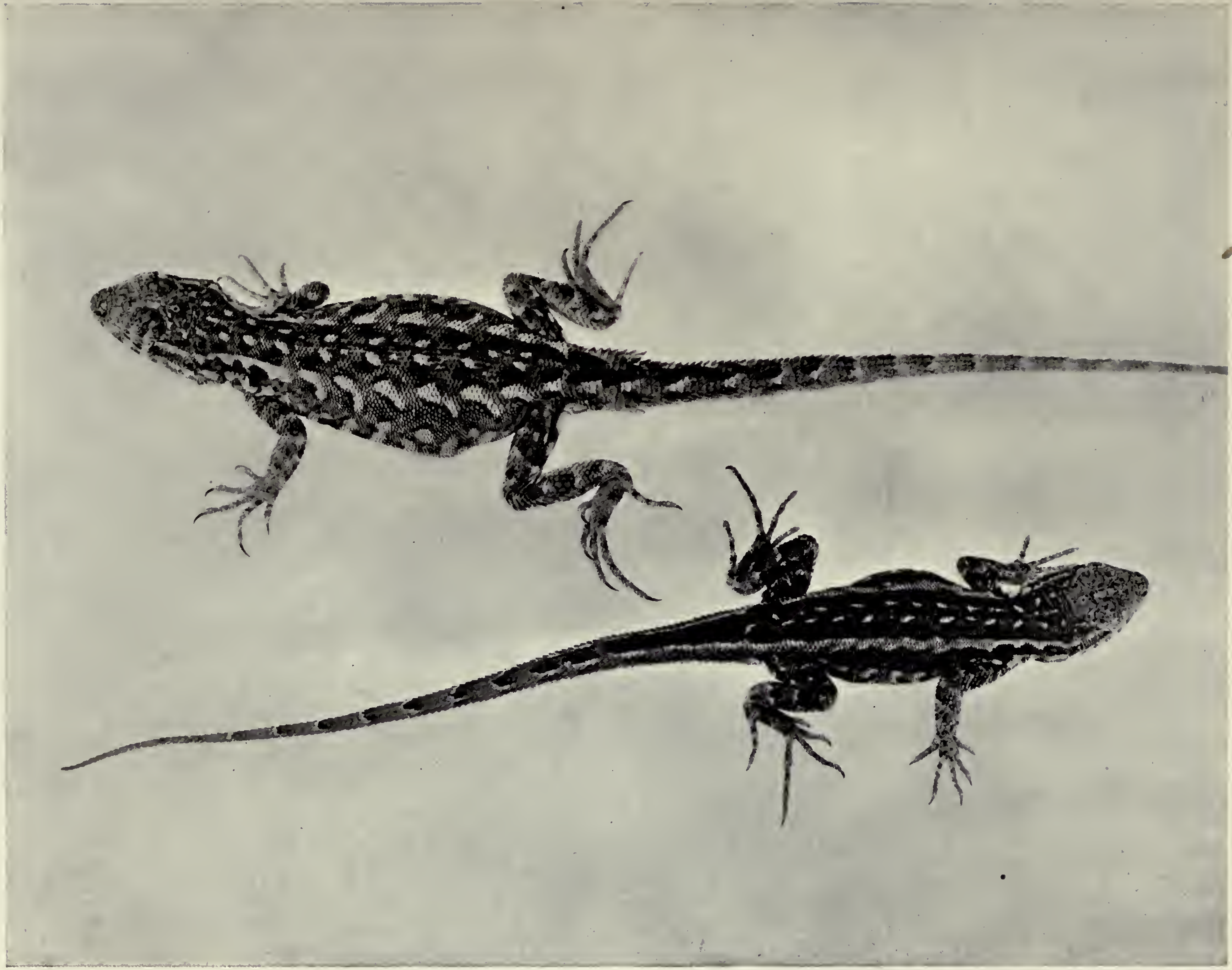
The Crested Lizard is a vegetarian and lives almost exclusively, it seems, on the flowers and leaves of desert plants and shrubs. Like most vegetarians, it is somewhat sluggish and does not approach in speed the rate of movement of the insect-catching daytime lizards.

In the holes of sand dunes, especially at the base of desert shrubs, the Crested Lizard lives, in the lower regions of the Mohave and Colorado Deserts, in southern Nevada, in Arizona south to Mexico, and in Lower California.

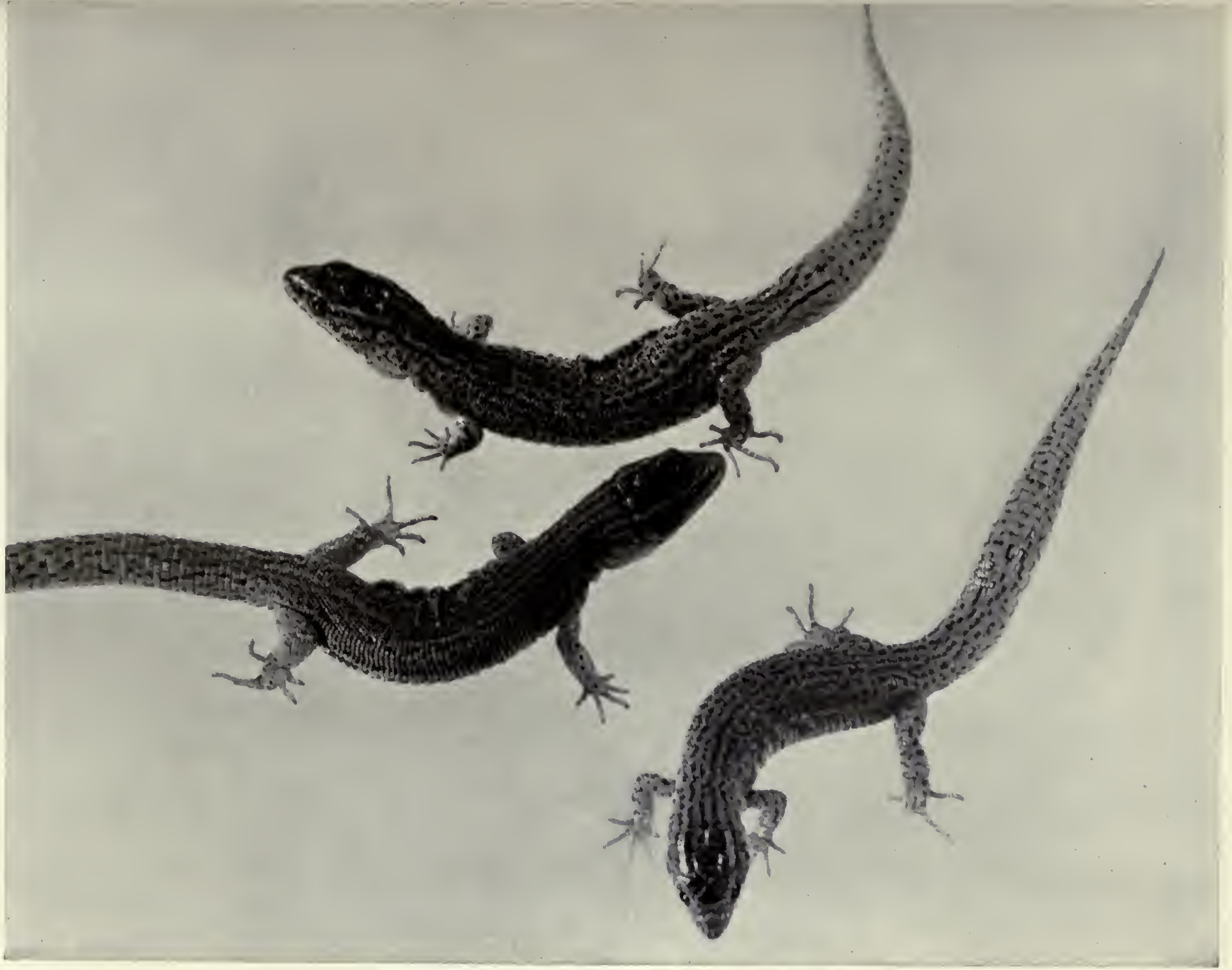
It is a large lizard and the picture shows it somewhat less than natural size.

Ocellated Sand Lizard at home on the sands of a dune in the Colorado Desert (Illustration 48). In the Colorado Desert east of El Centro of the Imperial Valley occur the famous Algodones Sand Dunes. These extensive shifting hills seem bare and lifeless when first inspected, for they do not have even mesquites or Creosote Bush. Closer scrutiny will disclose an amazing little lizard that has a perfect sand pattern. So perfect indeed that when it is not moving it is almost as invisible as if rubbed out of existence.

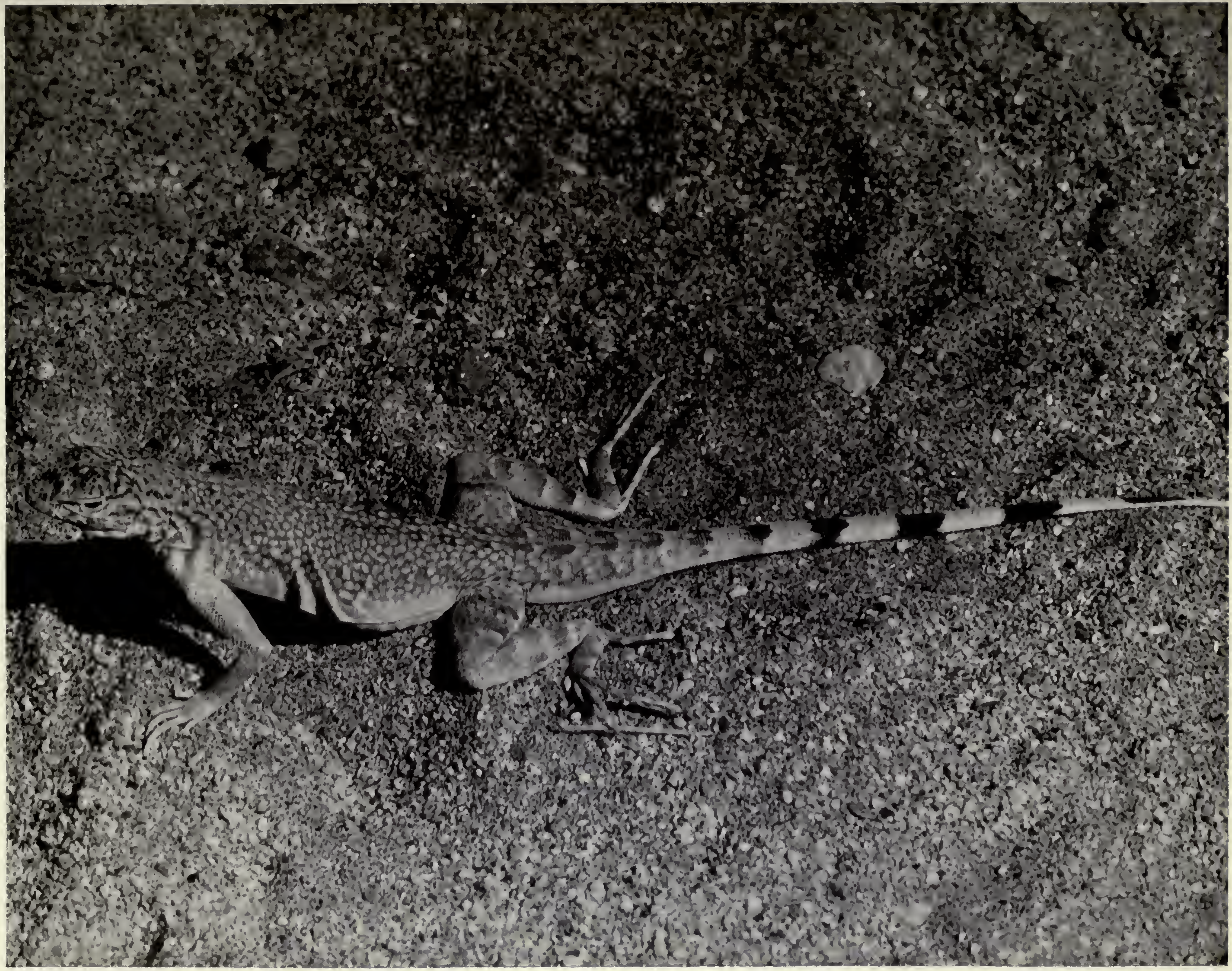
It is difficult to chase this fleet little reptile over the sand for the soft sand makes running impossible, and the lizard moves rapidly. Then, too, when one is almost upon it, it gives a flip, a quick push, and disappears truly by going out of sight into the sand.



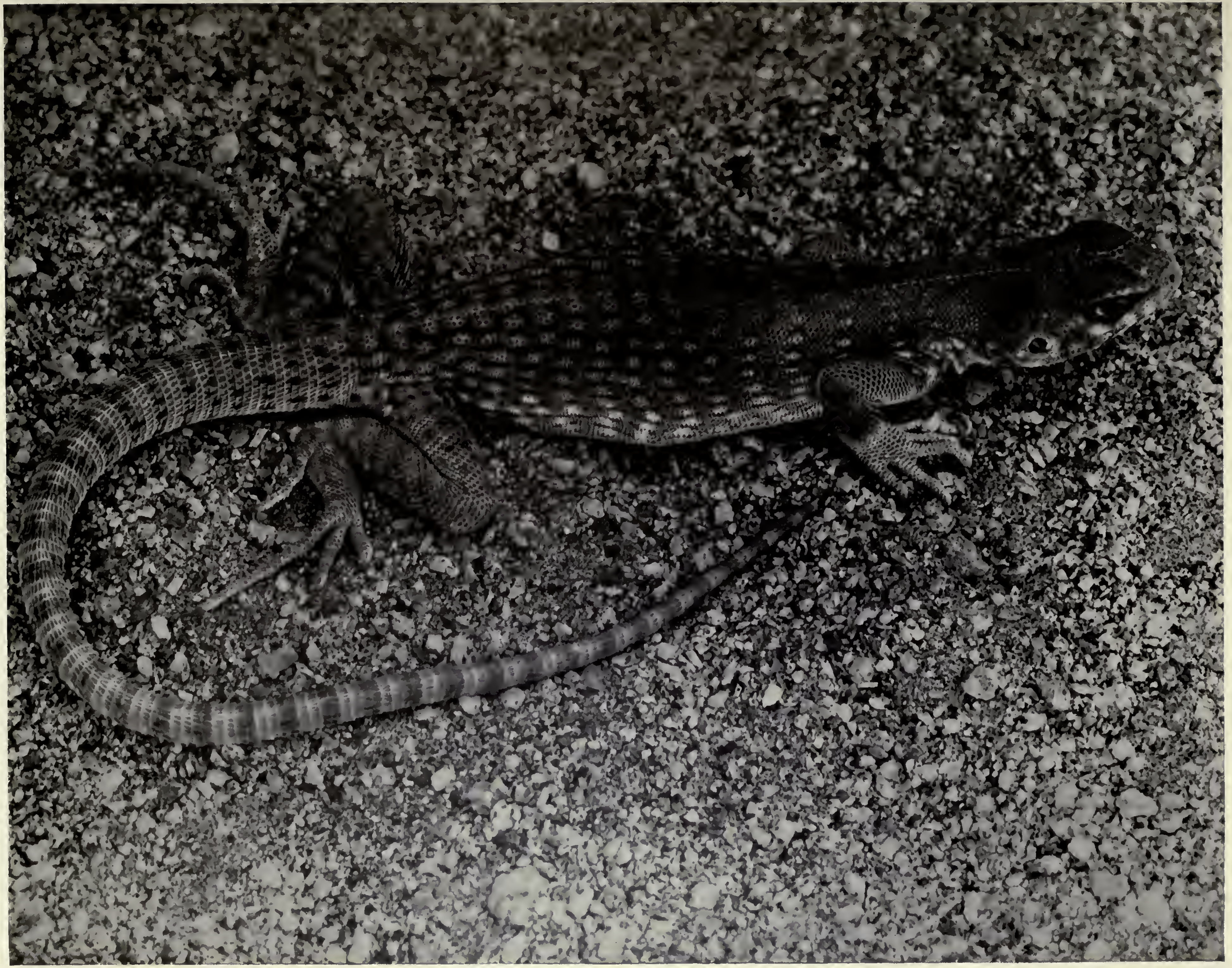
44. BROWN-SHOULDERED LIZARDS OF THE DESERT



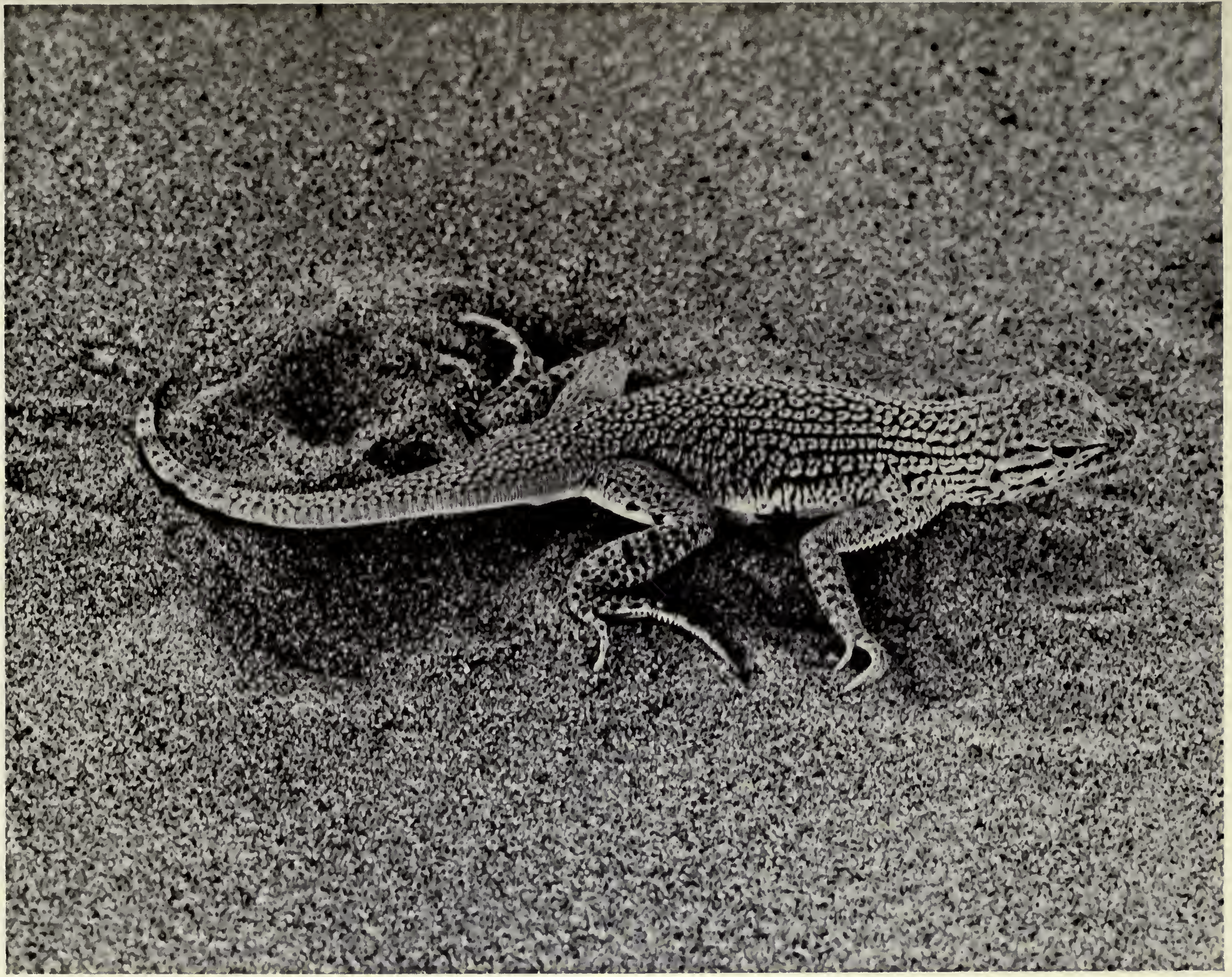
45. DESERT NIGHT LIZARDS



46. GRIDIRON-TAILED LIZARD



47. CRESTED LIZARD



48. OCELLATED SAND LIZARD AT HOME ON THE SANDS OF A DUNE IN THE COLORADO DESERT

The Ocellated Sand Lizard (*Uma notata*) is so adapted to a life in sand that it lives only where sand dunes occur in the deserts of the Southwest. For its life on the sand it has peculiar fringes of pointed scales on the toes to give a snowshoelike foot that assists in rapid running over the loose sand. (These may be seen in Illustration 48.) And the nose is flattened into a shovel form for rapid digging. This lizard eats some plant leaves, but also many insects.

Desert Scaly Lizard on a limb of Desert Ironwood in western Arizona (Illustration 49). The Chuckwalla is found only in the rocks, the Gridiron-tailed Lizard on the open desert, the Ocellated Sand Lizard only on the dunes, and this Desert Scaly Lizard is a climber in desert plants: the cactuses, the mesquites, and the other shrubs and trees. The individual of the picture was climbing on this Desert Ironwood, slipped around to the opposite side of the limb as we approached, and was finally photographed where it seemed so much at home.

The food of the Desert Scaly Lizard (*Sceloporus magister*) seems to be insects almost exclusively, as is the food of most of its relatives, the swifts. Only occasionally does it seem to take plant leaves or blossoms.

This little reptile, with scales that make it appear armor-plated, is fully protected from the sharp thorns of the cactuses among which it travels so swiftly and so easily. Its coloration is such that when it becomes quiet, as it does when enemies approach, it appears to be merely a knot or a bulge on the plant on which it stalks its insect food.

The Desert Scaly Lizard occurs widely in the deserts of the Southwest. It, and all other lizards shown in *Deserts*, is harmless to people.

The one in the picture is about natural size.

Chuckwalla, inflated (Illustration 50). Chuckwalla stands at the head of all animals of the desert in rhyme, story, and legend. This is rightfully so, for it heads the list in interest. If you inspect carefully a detailed map of the desert regions, you will find Chuckwalla exceeds slightly the Sidewinder in total number of names it has given to the desert. We captured our first in a canyon that runs down from the Chuckwalla Mountains (an extension of the Little San Bernardinos), and we were so excited and elated that we took a clue from desert pioneers and named the spot "Chuckwalla Gulch."

Chuckwalla is a big vegetarian, which eats by preference the blossoms of desert plants. In captivity, one of ours refused almost everything but blossoms of pansies. When hard put, though, they have been known to eat such plebeian food as the leaves of the Creosote Bush. Like all the vegetarians of the desert, the Chuckwalla leaves the winter home among the rocks much later than do the insect eaters. We have found them out and sunning in the Colorado Desert in late March, but we have never seen them in the higher and colder Mohave at that time of year.

When the warmth of desert sun finally calls, the Chuckwalla comes forth with a hide made up of folds and wrinkles, ascends the blistering hot rocks or clambers up the shrubs for the meal of blossoms. When eagle, or falcon, or human being appears, then Chuckwalla slips into a rock crevice and waits. If the enemy attacks, then Chuckwalla fills itself so full of air that it wedges tightly in the niche. Not even the strongest tug will dislodge it. The Chuckwalla of the picture was captured before it could get to a hiding place, but it blew itself up regardless, as you can see.

Chuckwalla, deflated (Illustration 51). The Chuckwalla lost its big breath naturally as we waited quietly beside it. To be impressed by the difference in size of the inflated and the deflated Chuckwalla, compare the pictures. Carefully note the tight skin of one, and the slack and wrinkled skin of the other. It is the same animal and was not touched or moved between photographs.

White men who have tasted the cooked lizard write that it is excellent, and desert Indians consider it one of their greatest delicacies. On their Chuckwalla forays, the Indians carry a pointed wire. With the wire they puncture and deflate the Chuckwalla in order to withdraw it from the niche to which it has retreated.

In addition to the inflation method of defense, the Chuckwalla has one other surprise for its enemies. It uses its big, muscular tail as a club. The very real thwack it can deliver is a big surprise for him who first feels it.

The Chuckwalla (*Sauromalus ater*) has many color variations. Mostly the big lizard is a mottled mosaic of black and white, a color pattern that matches faithfully the granite rocks among which it lives. A male that we found had extensive mottling of brick red. The Chuckwalla lives among the rocks of the lower slopes of the desert mountains in the Mohave and Colorado Deserts, in southern Nevada, western Arizona, and Lower California.

Desert Horned Toad (left) and California Horned Toad. (Illustration 52). At the word "desert" there comes to mind, very largely because of legend and story, a picture of weird creatures, a picture of scorpions, of centipedes, of rattlesnakes, and certainly of horned toads. All these do occur in the deserts, but none more appropriately than the horned toad. It is a creature of sun, and dry, and hot. Where the heat shimmers up in dry air, there the squat form of horned toad may be seen scuttling over dry earth or sand.

The Desert Horned Toad (*Phrynosoma platyrhinos*) occurs in the deserts of the Southwest, in Utah, and in Nevada. One early morning, just outside of Reno, we saw a Desert Horned Toad awakening. The sun had newly touched an area of sand and a movement appeared on the smooth surface there. We gazed in fascination, for as in slow-motion pictures, the horns, the head, the body, and the tail came slowly up out of the sand. We were reminded of the legendary Phoenix Bird arising from its ashes.

The California Horned Toad (*Phrynosoma blainvillii frontale*) occurs widely in California, but in regions more humid than those occupied by the Desert Horned Toad. Its darker coloration would prove that it comes from regions with more rain, for one of the outstanding characteristics of desert animals is their coloration, pale to match the world of light in which they live. The California Horned Toad beside the Desert Horned Toad gives emphasis to the paleness of desert color.

Horned toads seem to live exclusively upon insects, and they will learn to take this type of food from one's fingers.

There are several kinds or species of horned toads. They occur widely through the West, and east to Texas.

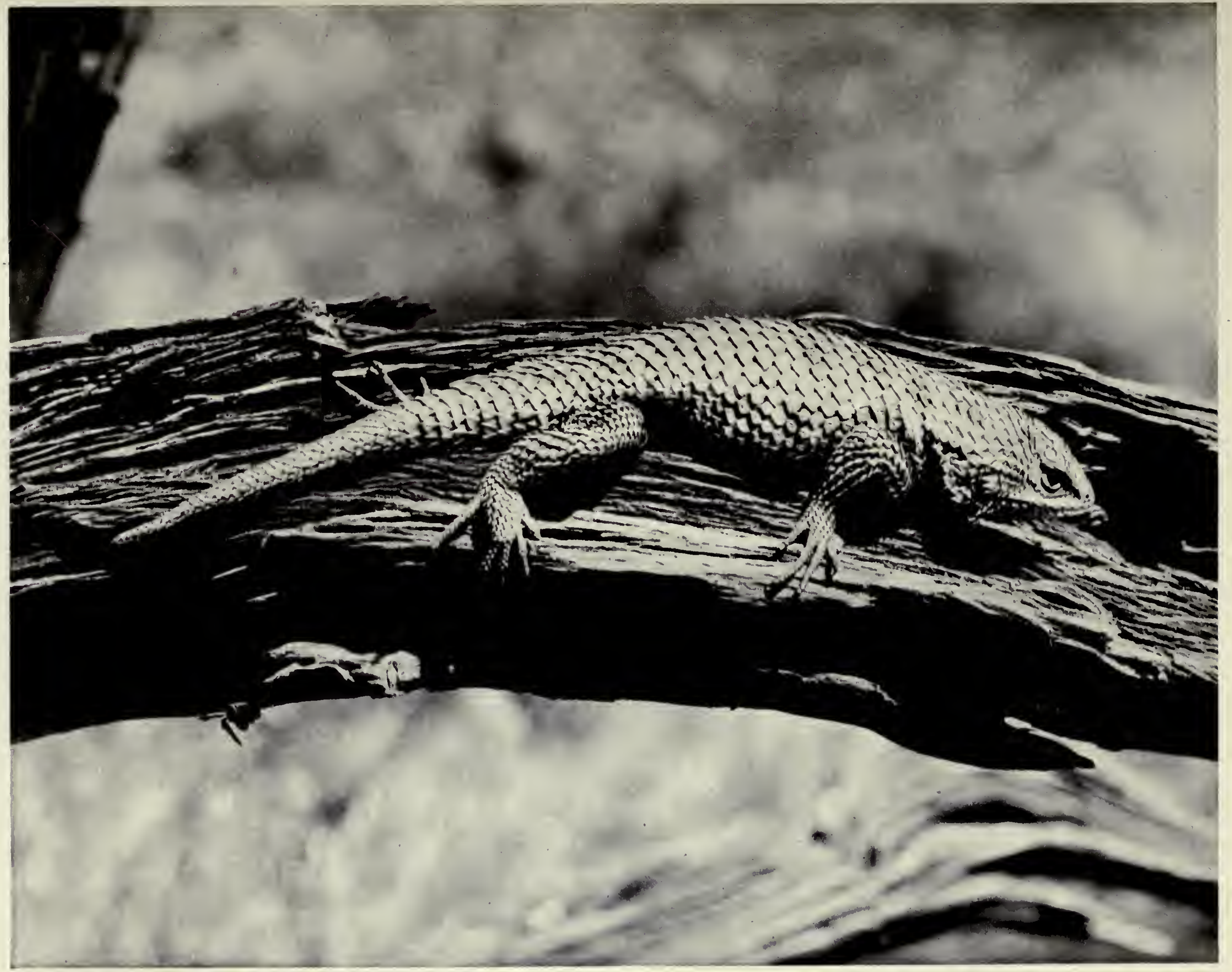
It may be necessary to remind you that horned toads are not toads, but lizards, as their scales and tails prove, but the name "horned toad" will stick.

The picture shows the horned toads about natural size.

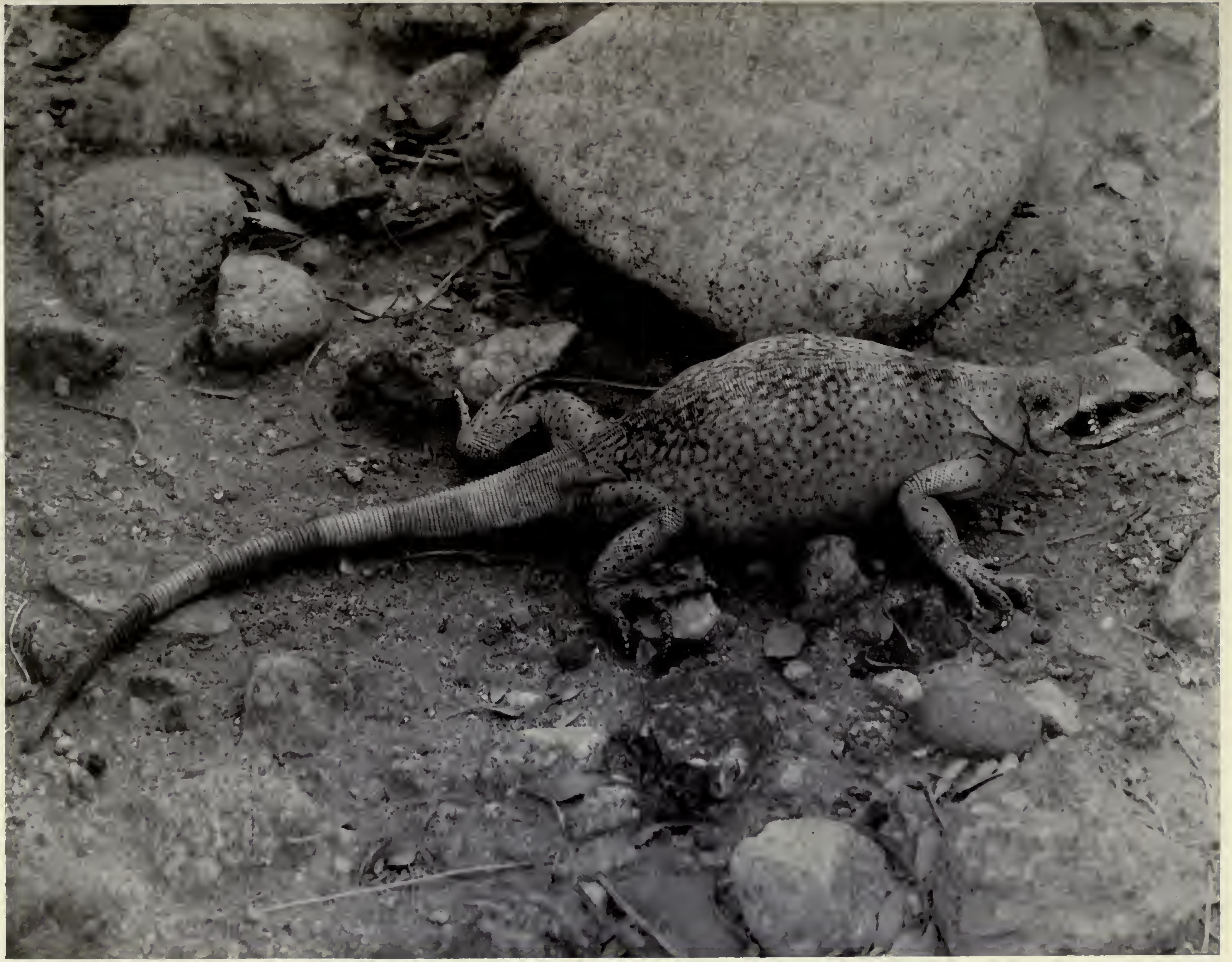
Red Racer (Illustration 53). On one of our desert journeys we first met the Red Racer in the act of swallowing a Whiptail Lizard. It came about in this way: the Whiptail Lizard proved the most difficult of all desert lizards to snare, even more difficult than the "fast-as-light" Desert Gridiron-tailed Lizard. It just couldn't be taken because it never stopped when you were near, but continued to go and go. One especially nice Whiptail was followed until it went down a rodent burrow. We began to dig in the sand and, sure enough, reached its tail. But that is all we did reach, for then we uncovered a Red Racer that had all the remainder of the Whiptail inside itself.

The next Red Racer we saw was curled about a Verdin's nest, a very especial Verdin's nest in a Honey Mesquite. That Verdin's nest had been watched for days, until the young birds were nearly ready to fly. One morning when we went to the nest, a Red Racer was coiled about it. When the snake saw us, it slithered to the ground and disappeared abruptly with the magic of which a Red Racer is capable. Investigation showed that it had not had time to swallow the nestlings.

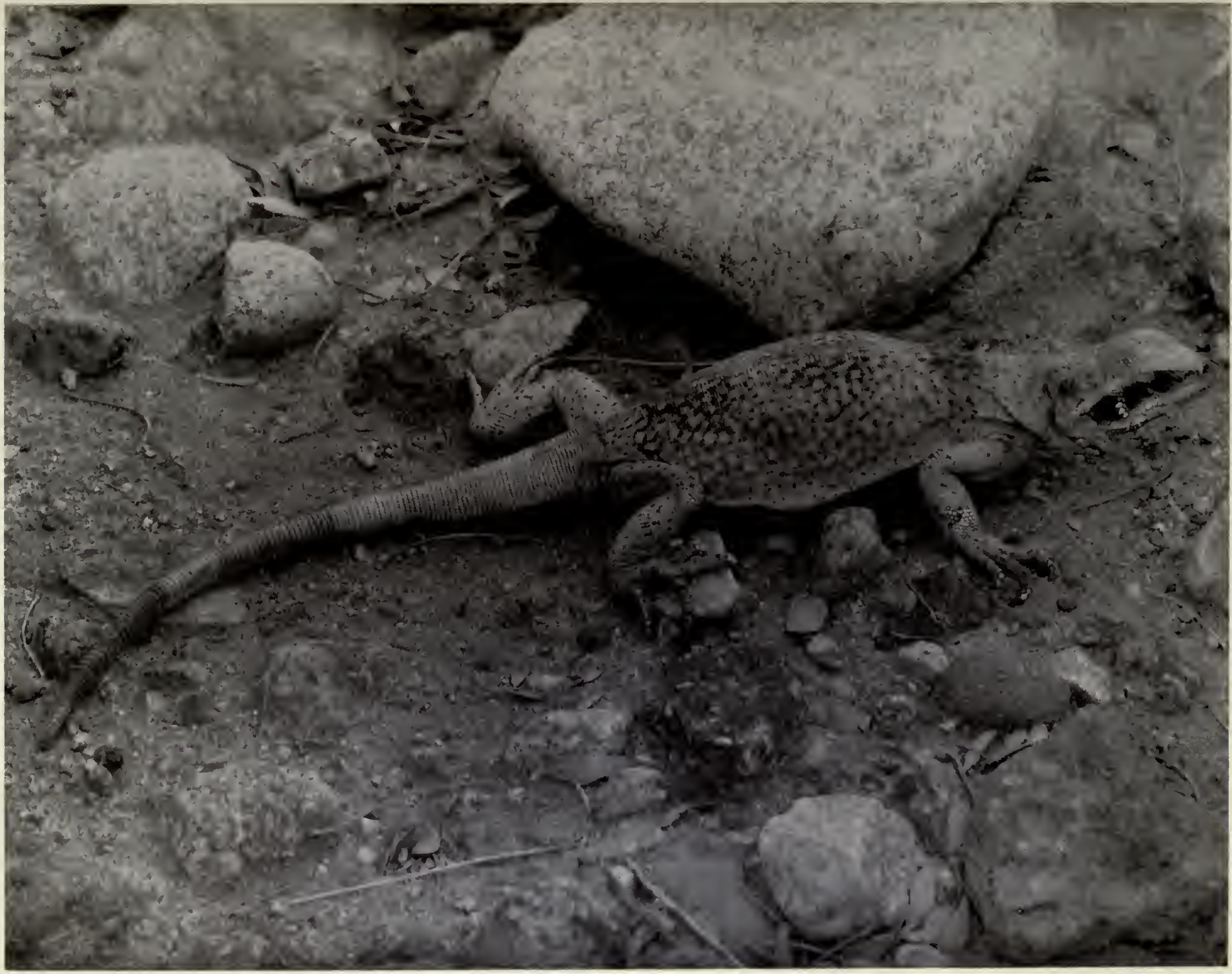
The Red Racer (or Western Whip Snake, *Coluber flagellum frenatum*) may be four feet or more in length, with the slenderest body that one can



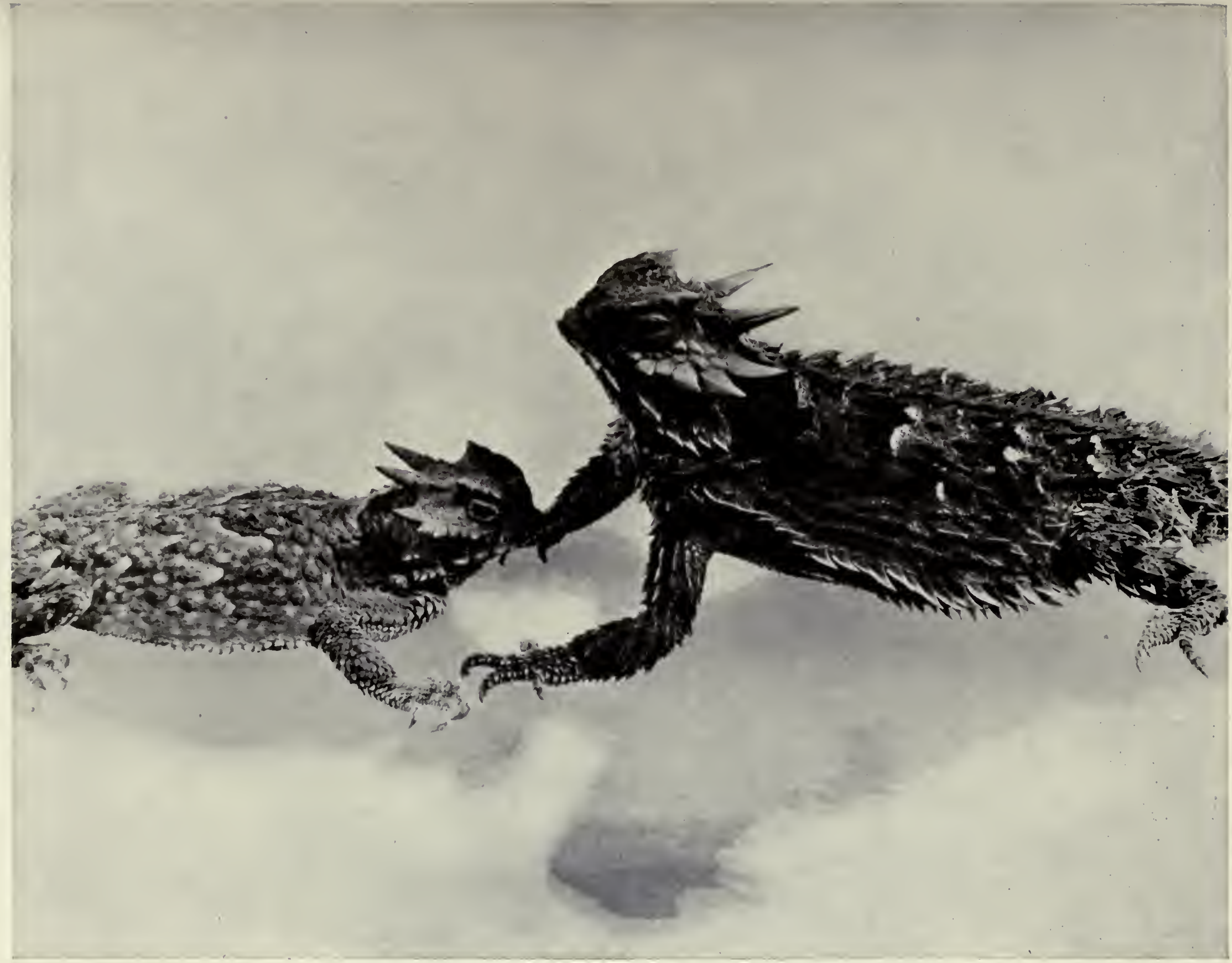
49. DESERT SCALY LIZARD ON A LIMB OF DESERT IRONWOOD IN WESTERN ARIZONA



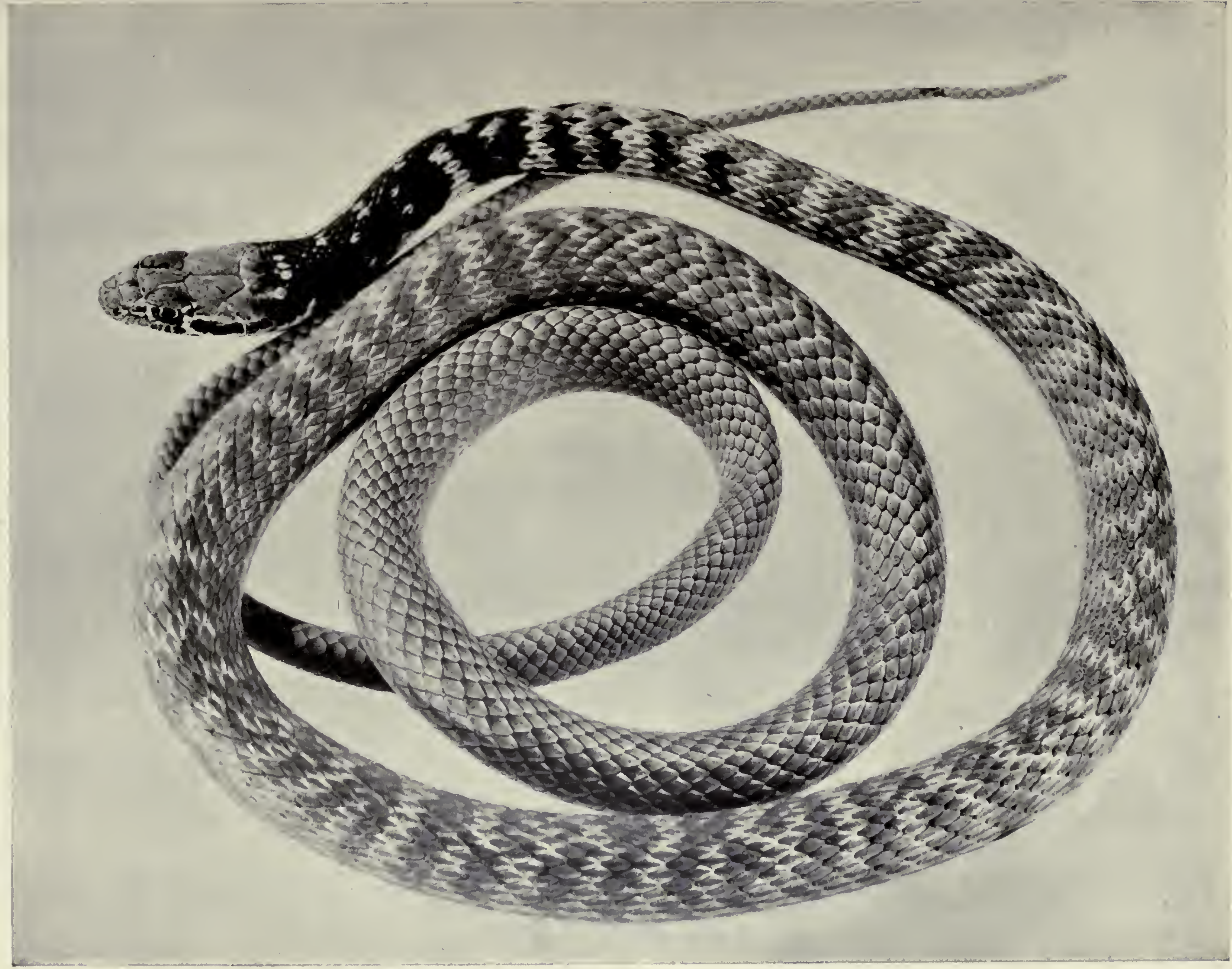
50. CHUCKWALLA, INFLATED



51. CHUCKWALLA, DEFLATED



52. DESERT HORNED TOAD (LEFT), AND CALIFORNIA HORNED TOAD



53. RED RACER

imagine a snake possessing. The scales of its tail seem to be neatly laced like a carefully made reata. Across the neck region there are several wide black bands, and the ground color for the remainder of the snake's length is brown, but the entire snake is suffused with a pinkish tinge. From this last color comes the name "Red Racer." The Red Racer occurs throughout the deserts of the West, and south to Mexico. It is also found in the southern coast region and in the San Joaquin Valley.

Desert Diamond Rattlesnake (Illustration 54). Everyone knows there are rattlesnakes in the desert, several species in fact. The rattlesnakes take a place among several other desert items that have been overplayed, as one of the "terrible," or "fierce," or "dangerous" things that one must "beware of" in desert travel. As a matter of fact, one is not likely to see rattlesnakes even in the desert, unless one goes off the beaten path to look for them. And when you find them, if you will allow yourself to notice, you must concede that rattlesnakes are gentlemen and always give you the opportunity to "draw first." If you refuse the challenge, they then withdraw without delay.

This Desert Diamond Rattlesnake was one such. While crawling on hands and feet through a mesquite thicket near India, we heard the buzz of the snake, only two or three feet away. Through the use of a stick crotch, it was pinned down, grasped behind the head, and brought into the open. We posed that four-foot, thirteen-rattle rattlesnake on the ground and took the pictures then and there.

The Desert Diamond Rattlesnake (*Crotalus atrox*) has a pattern of markings that will always excite admiration in one who sees the beauty of nature. It may have been this snake that gave ideas of design to the Hopi and Navaho Indians. It occurs from the deserts of California east to Texas. It is most abundant in the lowlands of Arizona.

Sidewinder Rattlesnake (Illustration 55). After the Chuckwalla, the Sidewinder is the desert's most famous member of legend and story. There are "Sidewinder Springs" and "Sidewinder Wells" on the detailed desert maps. The Sidewinder is reputed to be pugnacious, but we have found it peculiarly uncombative. The Sidewinder is said to be especially deadly, but cases of death or even cases of people bitten are almost impossible to trace to an authentic source. But the Sidewinder remains a picturesque desert item because of its home and because of its habits.

Whereas most of the desert rattlesnakes are found among the rocks of the mountains, or on the hard soil beneath the brush on the lake beds, the Sidewinder is the rattlesnake of the loose and shifting sand. It travels in its sandy home by looping itself sideways, and not straight ahead. This is the only successful method of travel for a snake in soft sand; and from its method of travel the Sidewinder gets its name.

The Sidewinder is active at night, and not during the day as is true with most rattlesnakes. In the nightly sidewinding the meals of mice, kangaroo rats, lizards, and even horned toads are secured. When day and sun come again, the Sidewinder lies, just covered with sand, usually in the shade of a desert shrub. It is claimed that full exposure to the desert sun will soon kill a Sidewinder.

The Sidewinder, or Horned Rattlesnake (*Crotalus cerastes*), is comparatively common in the low sandy portions of the Mohave and Colorado Deserts, in southern Nevada and across Arizona. This little rattlesnake, which is usually only about two feet long, may be recognized because of its sandlike color pattern, and the hornlike scales above its eyes.

Desert Tortoise (Illustration 56). This remarkable turtle closes our examples of reptiles. It is no mud turtle, because it never sees mud. Even water, except for occasional rains, it never knows. It lives in the deserts of southern Nevada, or Arizona, in the Colorado Desert, and most abundantly in the Mohave. It lives in a land without ponds or puddles, and without streams.

Desert Tortoise (*Gopherus agassizii*) digs a burrow into the sand or gravel at the edge of a wash or beneath Creosote Bush, and spends the hottest portions of the summer there. In its burrows it hibernates during the cold Mohave winter. Only after desert vegetation is at its prime, in April, May, and June, is it especially active. Then it comes forth, plodding along from plant to plant, to browse. It is seen commonly along the Mohave roads in June, and too frequently travelers pick up the harmless and lumbering fellow to carry it away from its native home.

The Desert Tortoise has an extraordinary method of supplying itself with water when desert vegetation is no longer lush. Two sacs lie along its upper surface within the shell and these become filled with liquid. In large turtles, these sacs are said to hold about a pint and constitute the Desert Tortoise's answer to the water problem.

Texas Nighthawk on her nest (Illustration 57). This bird presents a truly amazing example of protective coloration. So protectively colored is she that you must look carefully to make out the full outlines. The brown and barred feathers seem made for the gravel upon which she sits. The nest is merely two eggs like pebbles. The bird is covering the eggs and relying so firmly upon the concealment of her colors that it is necessary nearly to step on her before she flies.

The Texas Nighthawk lives in the Southwest and Far West. The bird nests extensively in the true deserts, but also in desertlike conditions in valleys to the north. The Nighthawk of the picture nested on the gravel of a dry stream in central California. An experience on the edge of the Mohave, however, that included the Texas Nighthawk, stands forth as one of the most memorable of all desert impressions.

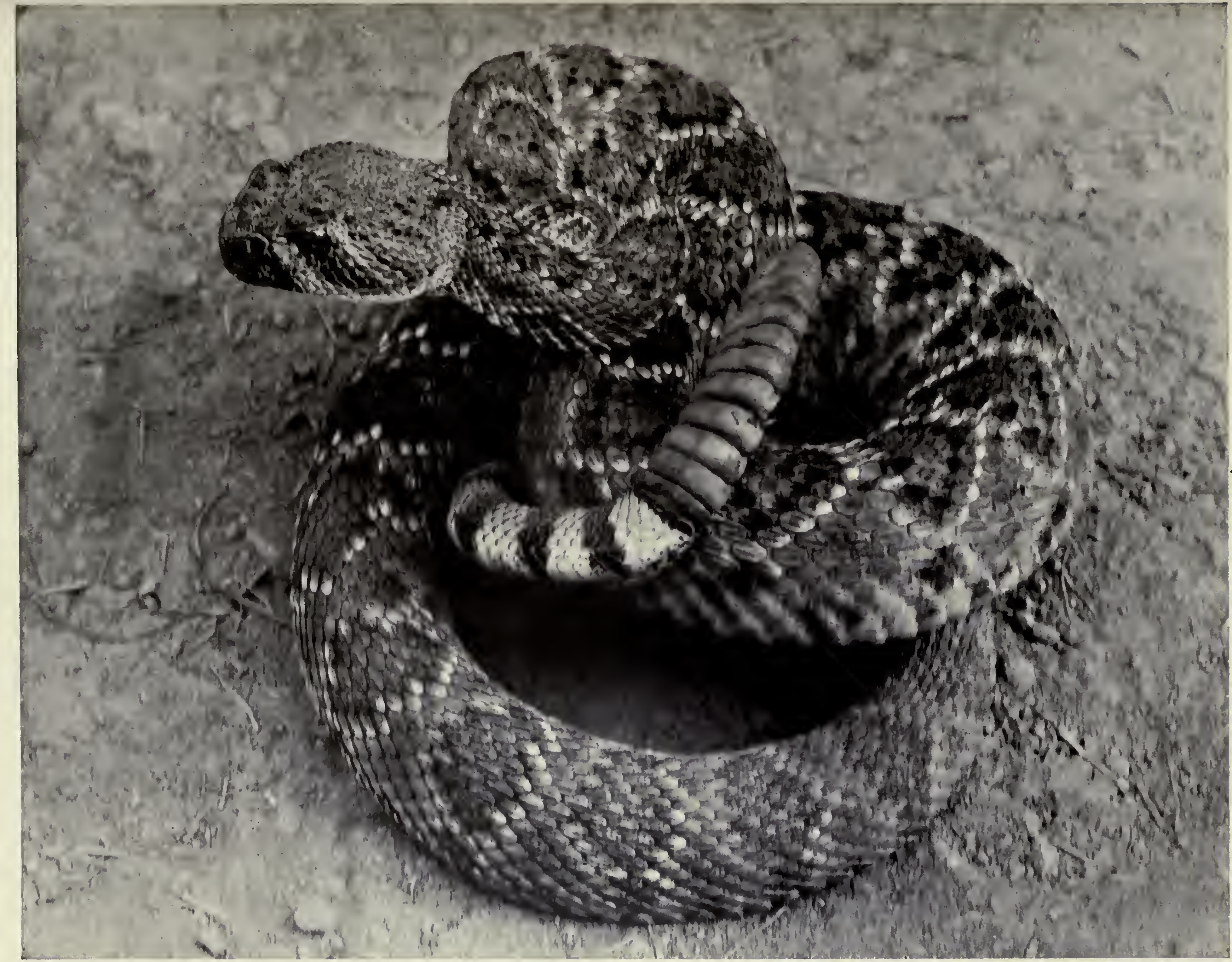
A large group of us were enjoying a barbecue on June 22 at the foot of Johnson's Grade just below the San Bernardino Mountains on the edge of the Mohave. A grove of Fremont Cottonwoods in an oasis there supplied us with a site for our fire. The desert evening was quiet and delightfully balmy. Clouds in the west gave color and beauty to the sunset, a beauty that can be equaled only in a desert. As the night came on there came, too, the voices of the desert. High above the cottonwoods a Pacific Nighthawk called its rasping "bayard." It had come down from the rock piles of the mountains to take advantage of Mohave good hunting. A Poorwill sat on the ground beside the great campfire and leaped into the air to catch the insects the fire had brought. Above the singing voices of human beings there came a puttering of a bird that was slipping back and forth through the cottonwoods. It made the third and last of the Western Goatsuckers, or Nightjars, all of them on the fringe of the desert. This last was the Texas Nighthawk.

Nest of the Verdin in Honey Mesquite (Illustration 58). Wherever the clumps of mesquite, Cat's-claw, or Palo Verde occur in the desert, there you can expect to hear an almost constant, petulant, and complaining "cheek, cheek," or maybe you hear the weak little song "swee, swee, swee." This is the voice of the Verdin, a true bird of the desert. It will require patience to see the yellow head and ashy-gray body of the midget Verdin, but its nests cannot be missed.

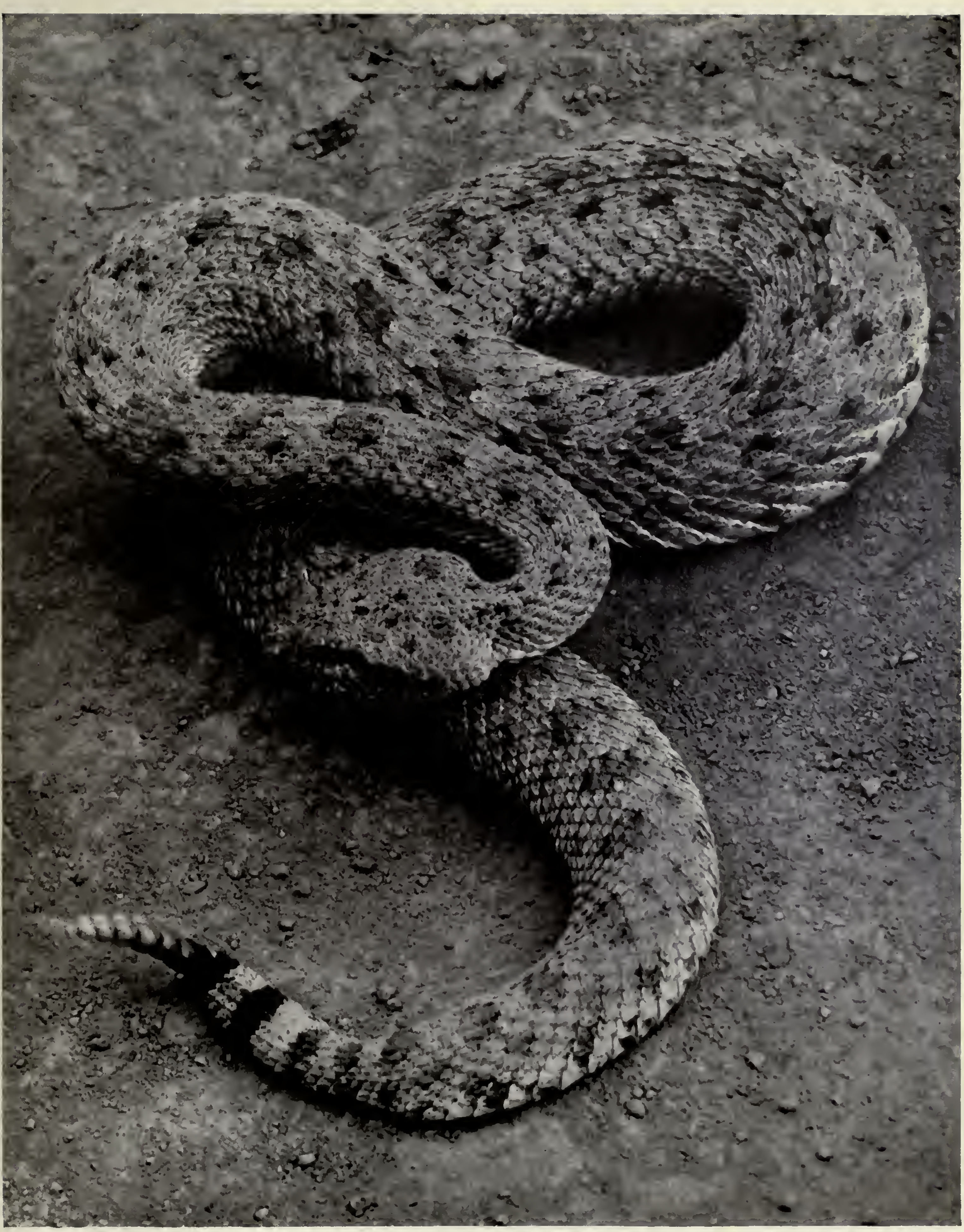
In March, before the mesquite has produced its leaves, the Verdin piles together its great mass of thorny twigs. The bird is no larger than a chickadee and is a member of the same family, but its nest pile may be football size. At one end of the thick pile of thorns there is an opening. The opening leads back to a grass-lined nest cup inside.

With a formidable pile of thorny twigs, one would feel that the Verdin's nest would be safe from all enemies. But we found a Red Racer with its head inside a Verdin's nest. In that particular case, we appeared on the scene before the snake had swallowed any Verdin babies.

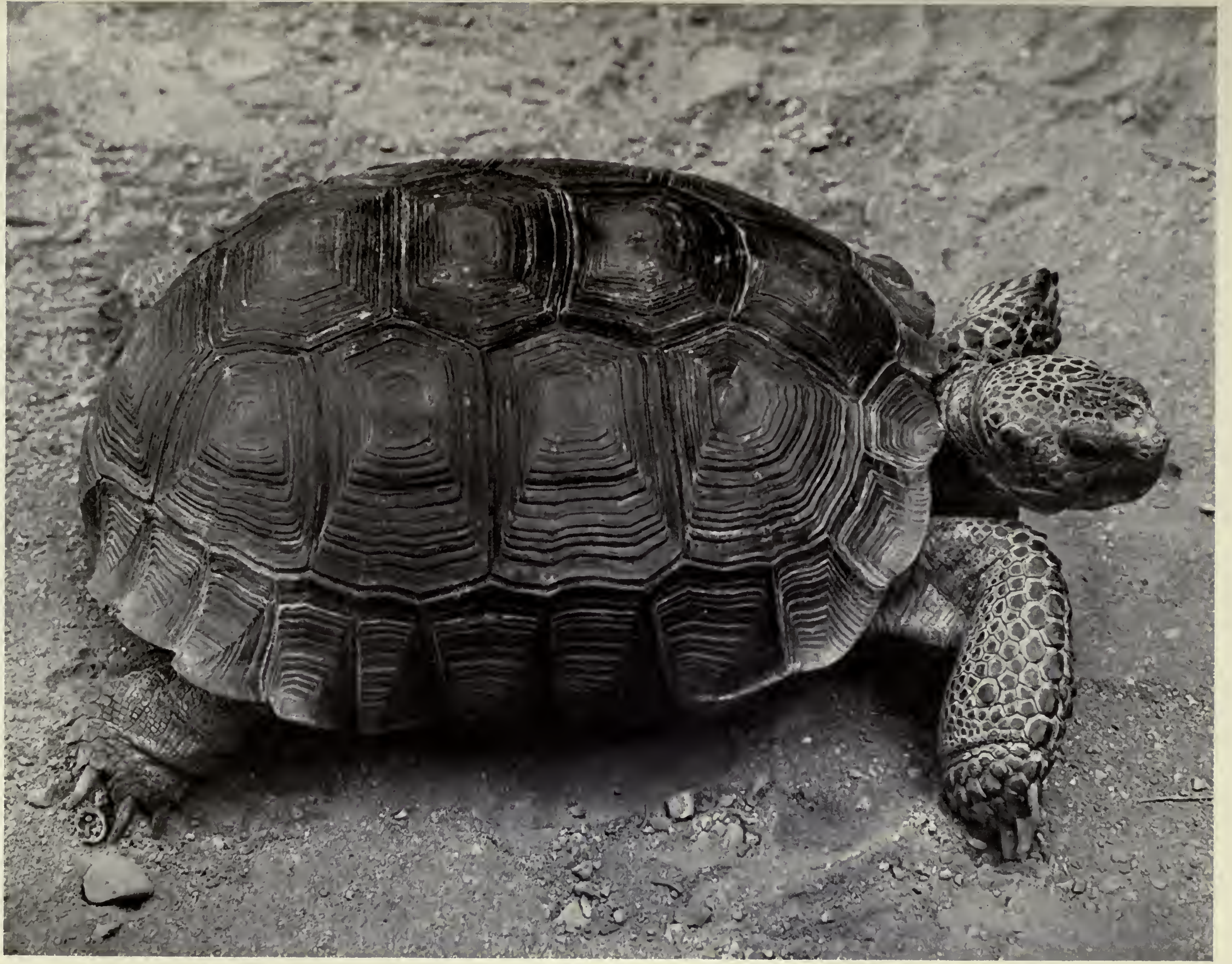
The Verdin is one of the commonest of desert birds. It follows the mesquite across south-



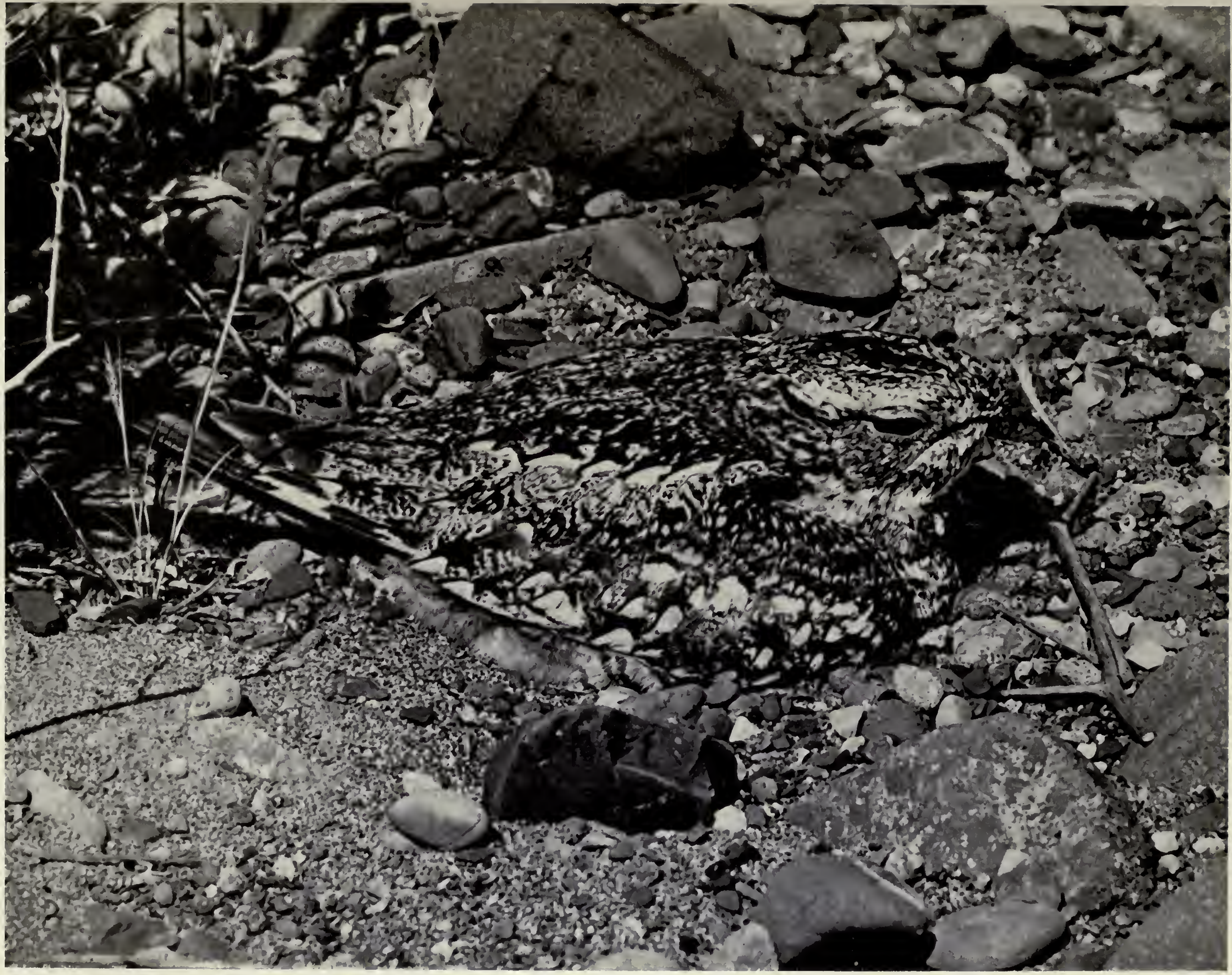
54. DESERT DIAMOND RATTLESNAKE



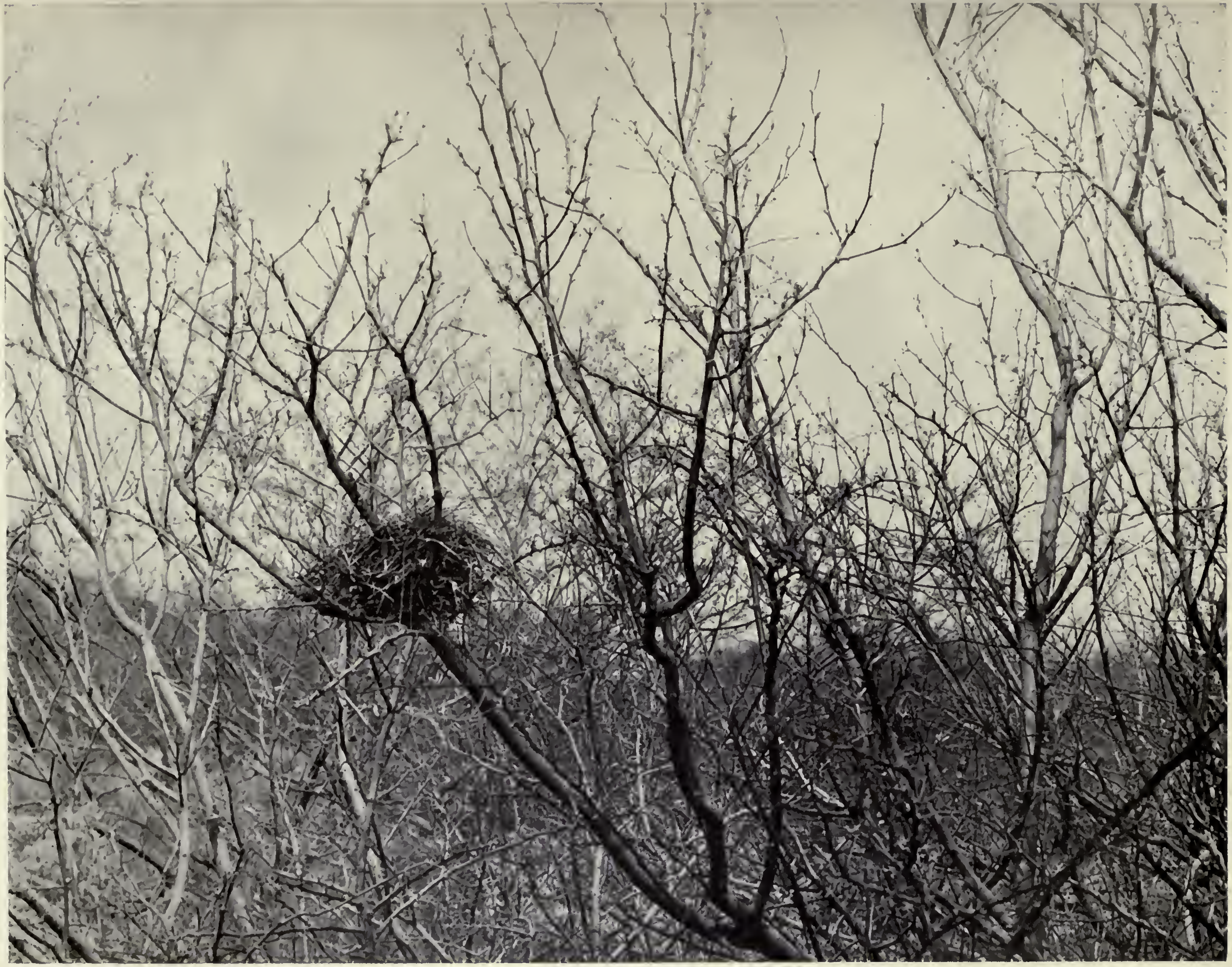
55. SIDEWINDER RATTLESNAKE



56. DESERT TORTOISE



57. TEXAS NIGHTHAWK ON HER NEST



58. NEST OF THE VERDIN IN HONEY MESQUITE

western United States, east to Texas, and south into Mexico.

Nest of Cactus Wren in Deer-horn Cactus (Illustration 59). The next most abundant and conspicuous nest of the desert, after the nest of the Verdin, is that of the Cactus Wren. It is a poor devil's garden of Cholla that will not display two or three grayish balls of material, wedged near the top of the Cholla, among the murderous spines. After the Cholla, the closely related Deer-horn Cactus seems to be favored by these nest balls with their side-door openings. These are the nests of the Cactus Wren.

If the Verdin is the commonest bird of the desert, the Cactus Wren is the most distinctive. When the Cactus Wren sings, it climbs to the top of its cactus, or of a neighboring bush, and says, "chug, chug, chug, chug," like an ancient automobile making a preliminary start after being cranked. While it sits in view, one may note that the Cactus Wren is unusually large for a wren, and has a conspicuously spotted breast.

It is difficult to understand how this bird can thread its way through Cholla and Deer-horn Cactus so easily, when any other object is sure to be impaled by the treacherous thorns. The Cactus Wren not only seems to be at home there, but it builds its elaborate nest in the midst of the spines. It is probable that not even a Red Racer has ever molested the nest of the Cactus Wren.

Male Plumbeous Gnatcatcher going into nest (Illustration 60). The Plumbeous, or Lead-colored, Gnatcatcher is another desert bird of the mesquite clumps. It is so small, so dull of color, and so frequently concealed, that one would not know of its presence were it not for the constant, rasping "spee, spee, spee, spee, spee." This note may be heard almost as frequently as the "cheek" of the Verdin.

The nest of the Gnatcatcher is daintily made of fine plants fibers. The picture shows the nest, in a crotch of a Honey Mesquite shrub. Stalks of Encelia run through the Honey Mesquite.

In this case the male Plumbeous Gnatcatcher was less timid than the female, or maybe he had less fear for the safety of the nest, for he allowed us to set up big cameras and take picture after picture, without causing him to leave the eggs. In fact, when we wanted to get pictures showing the eggs, we had to touch him with our fingers to get him to leave. Even then he gave the fingers a peck with his bill before he went.

The Plumbeous Gnatcatcher occurs through deserts of the Southwest, east to central New Mexico, and south into Mexico and Lower California.

Birds of the desert solve their water problem in various ways. If they eat insects, they secure their moisture from this food. This is the method of Texas Nighthawk, Verdin, Cactus Wren, and Gnatcatcher. If they eat larger prey, such as mammals or reptiles, then again the moisture is secured from their food. This is true of the Prairie Falcon and the Raven. If they eat seeds, then they must make daily trips to the water holes or streams. Thus the Gambel's Quail and the doves of the desert must know the locations of water. Quail always live near the water, but doves may fly fifty miles daily for their drink.

A kangaroo rat from Death Valley (Illustration 61). This, the Big Desert Kangaroo Rat (*Dipodomys deserti*), is one of the largest of this strange tribe, and it lives in the most desert of conditions. It occurs in the Colorado Desert, in the Mohave Desert, and most commonly in Death Valley. Other kangaroo rats occur in the deserts, but there is no other as pale as this.

The extensive development of the hind legs, to free the forelegs from the need of their use in walking or running, has gone forward in many widely separated groups of mammals. Human beings head the list; then there are all the monkeys and apes, the kangaroos, jumping mice, and kangaroo rats. With the little forelegs, the kangaroo rats can pick up objects and hold them easily, but so can squirrels. No squirrel, however, can cover ground with the surprising leaps of the hind legs as can a kangaroo rat.

Desert Antelope Ground Squirrels are the mammal animation of the desert day, and kangaroo rats are the mammal animation of the night. Their big eyes prove that the kangaroo rats are creatures of the dark. The leaping forms of these rodents are frequently shown by the headlights of automobiles driving over desert roads.

The kangaroo rats, like the Desert Antelope Ground Squirrel, eat moist green foods when they can get them, but through much of the year they must live almost exclusively on seeds and other dry materials. They meet the water problem of this period by using carefully the water of metabolism.

Illustration 1 shows the region in Death Valley where the Big Desert Kangaroo Rat of Illustration 61 lived. Around the mesquite clumps and the Creosote Bushes, the tracks of these rats can be seen each morning. A live trap took one of these night prowlers and it was carried several hundred miles to the north where it was photographed. After that it became a pet and was carefully fed and housed for one full year. Then, on a second trip to Death Valley, it was carried back and released not far from where the camera stood to get the picture of sand dunes.

Nest mound of the Mohave Pack Rat (Illustration 62). Those of us who have lived in regions where pack rats occur have become accustomed to the big piles of brush that these interesting mammals make in the chaparral, or even pile in crotches of trees. In fact, one is inclined to think of this animal as the "wood rat," because that is where its work is most frequently noted. One hesitates to believe, therefore, that the mounds on the sands of the desert are made by pack rats. Such is the case, however, and beneath the Joshua Trees of the Mohave these mounds are quite common.

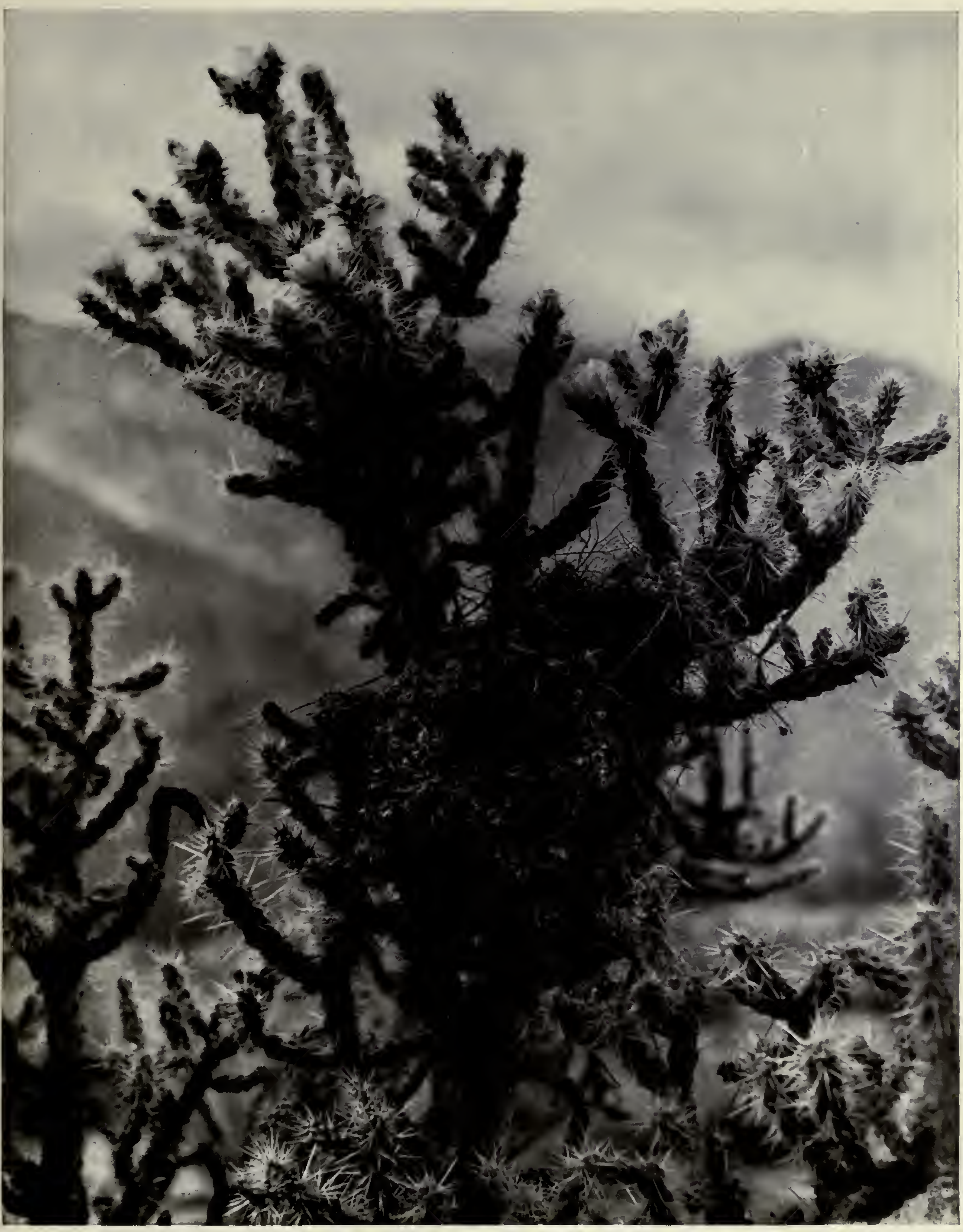
The mounds of the Mohave Pack Rat are an amazing collection of branches from Creosote Bush, Joshua Trees, small stones, and bits of cactus. In the center of the mound there is a small chamber of fine fibers, which is the sleeping quarters or perhaps the room for the babies. On a runway to one side of the sleeping or brood nest, the Mohave Pack Rat will have its toilet accommodations, for it always keeps its main room spotless. Near the sleeping room there will be the pantry. In the pantry there will be a collection of the fruits of the Joshua Tree, blades of Spanish Daggers, bits of roots, and other items of food. There can be no more interesting activity than looking into the home life of a Mohave Pack Rat.

This pack rat does nearly all its work, and its foraging, at night. It is not likely, therefore, that you will ever see one unless you uncover the inmate when you inspect the home. Then you will note the large eyes, proof of the night animal, and the large ears, that make the pack rat quite different from the common house rat.

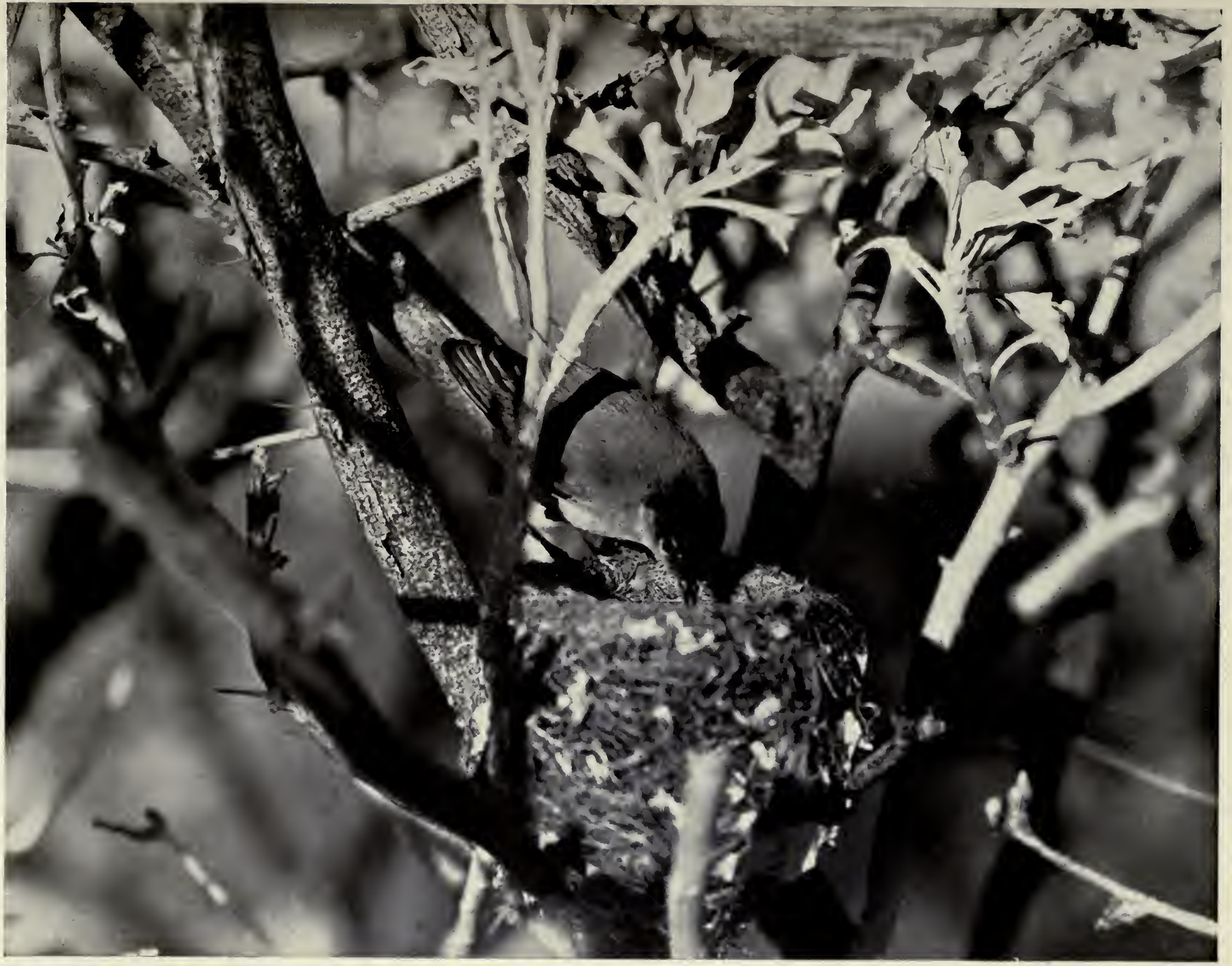
Desert Antelope Ground Squirrel (Illustration 63). After the lizards, the greatest animation of the desert sands comes from the hurried dash of the Desert Antelope Ground Squirrel running to its burrow. As it races along it carries its tail over its back like a white signal flag. Most of the small mammals of the desert are active only at night; but the Antelope Ground Squirrel scurries here and there, collecting food and burying it away, in the full light of desert day.

The Desert Antelope Ground Squirrel lives on seeds, stems, and cactus fruits. Cactus fruits supply water, but when such fruits are not available the Ground Squirrel must depend on the water of metabolism, as do Powder Post Beetles. In order to determine how long a Desert Antelope Ground Squirrel might live and be active without water, we kept one for more than six weeks without any free water. During this time the little animal ate grains of various kinds, and the nearest approach to tangible water that it received was a piece of fruit cake. Various observers have shown, however, that this ground squirrel will drink water when it is available, though the squirrel, like many desert animals, can live for long periods without it.

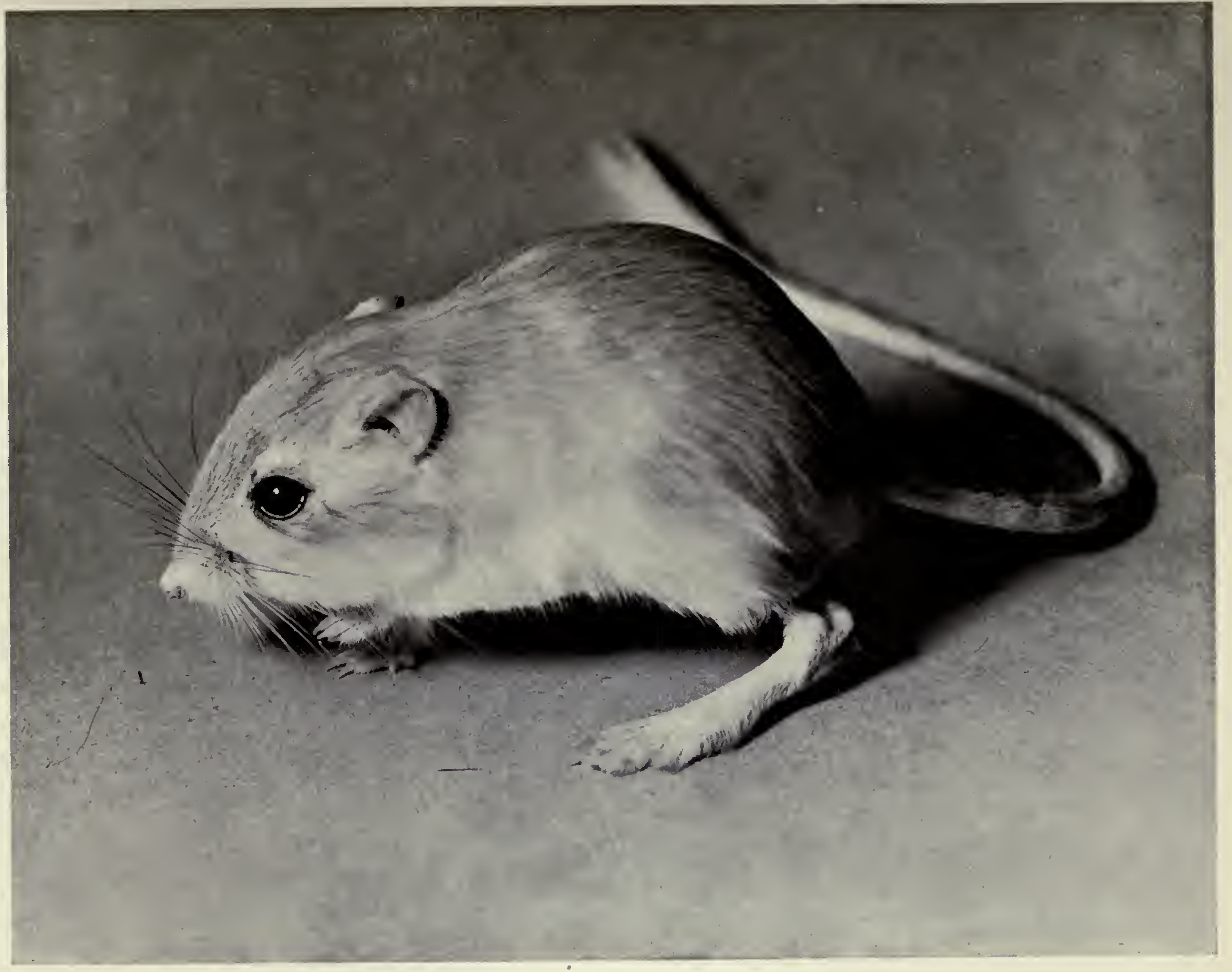
The first babies of the Desert Antelope Ground Squirrel venture out of their homes about the middle of April. We caught a baby at Palm



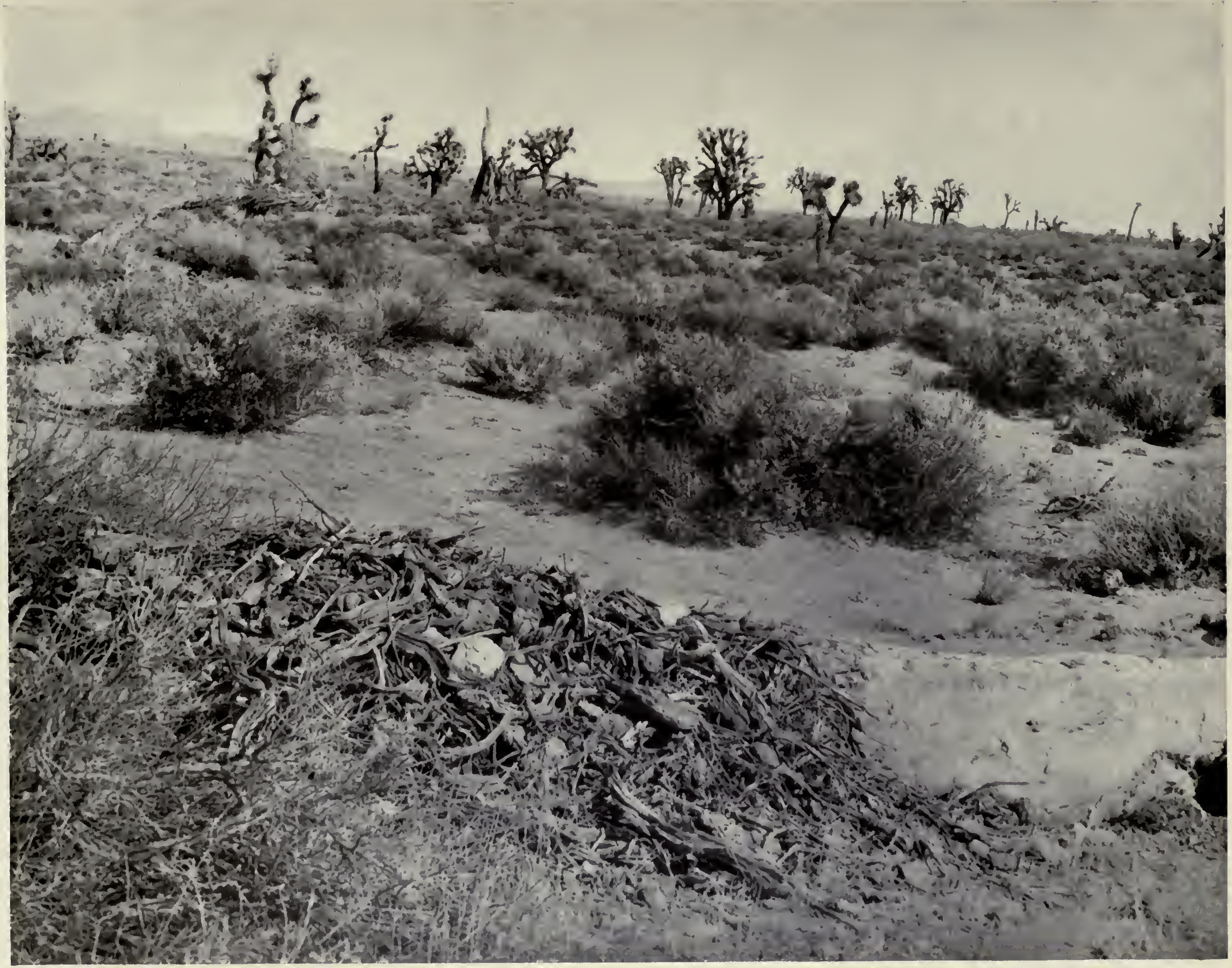
59. NEST OF CACTUS WREN IN DEER-HORN CACTUS



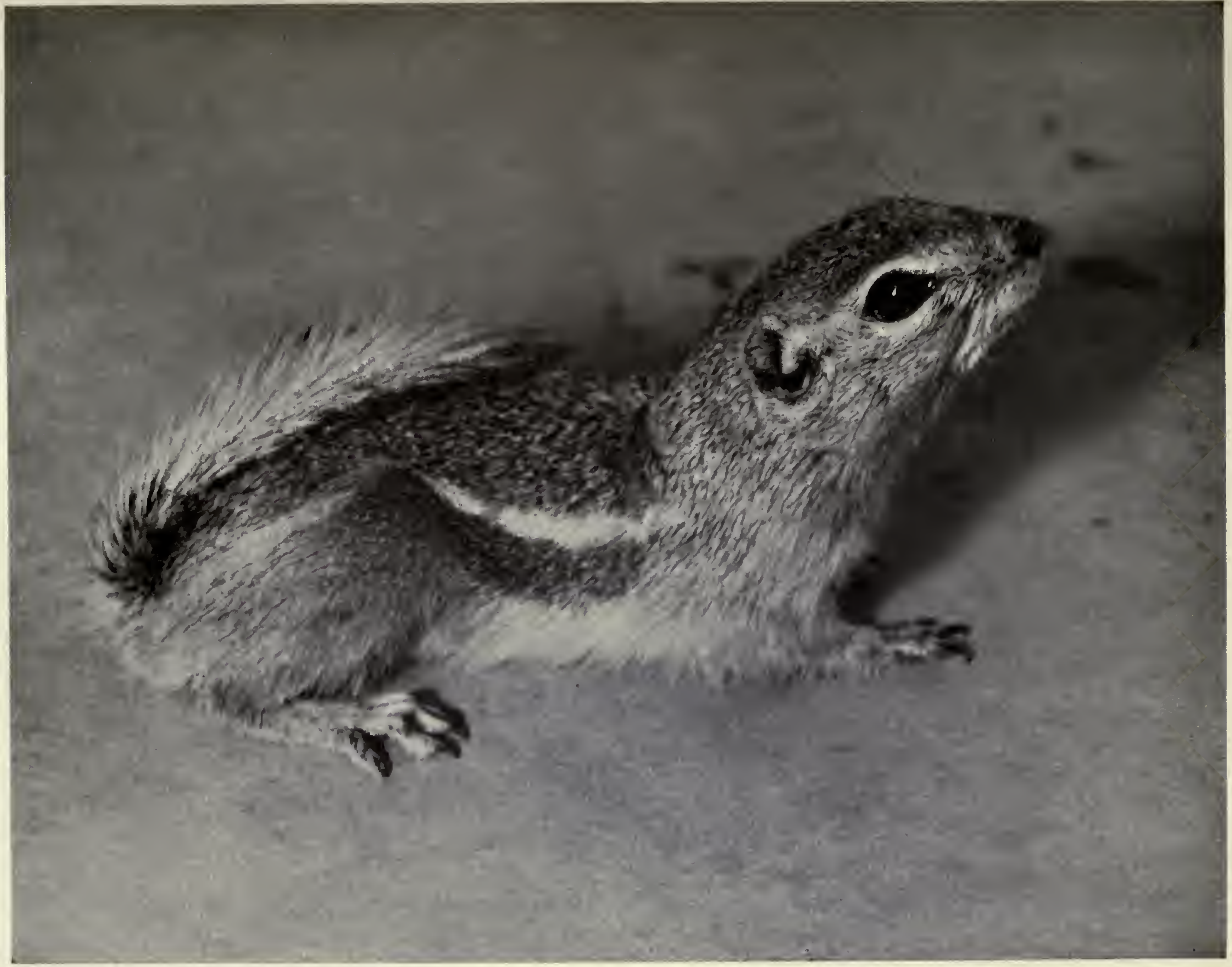
60. MALE PLUMBEOUS GNATCATCHER GOING INTO NEST



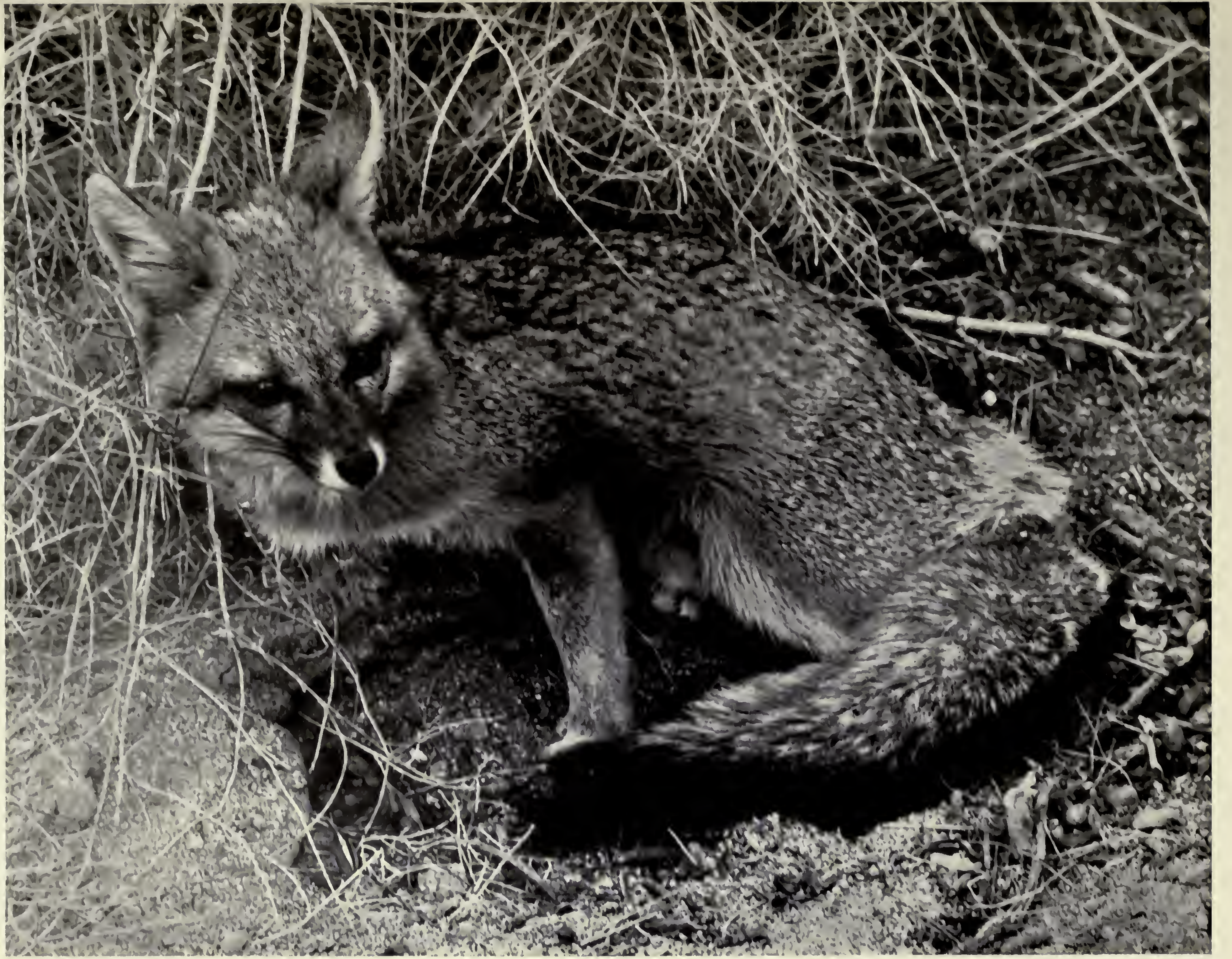
61. A KANGAROO RAT FROM DEATH VALLEY



62. NEST MOUND OF THE MOHAVE PACK RAT



63. DESERT ANTELOPE GROUND SQUIRREL



64. CALIFORNIA GRAY FOX

Springs on April 15. Since they have none of the nimbleness of their parents, they are prey for many enemies, shrikes, hawks, ravens, snakes, weasels, and many others. In order to keep the tribe of Antelope Ground Squirrels in sufficient numbers to populate the myriad burrows beneath the desert shrubs, it is necessary for two or three broods, of six or seven each, to be born each year.

The Desert Antelope Ground Squirrel (*Ammospermophilus leucurus leucurus*) occurs throughout the deserts of California. Other varieties of the Antelope Ground Squirrel may be found in all the desert regions of the West and Southwest.

The picture shows the Desert Antelope Ground Squirrel a little larger than natural size.

Gray Fox (Illustration 64). The deserts of the Southwest seem to be especially suited to foxes. It is here that the Kit Fox, a true native of the desert, occurs. The Gray Fox, though it may range over the entire United States, reaches its greatest abundance in the desert.

There are several varieties of the Gray Fox, and the one of the picture is the California Gray Fox (*Urocyon cinereoargenteus californicus*). This fox frequents the deserts' margins and follows the streams down the mountains to the sands. It was at the edge of a stream near Palm Springs, at the foot of the San Jacinto Mountains, on the margin of the desert of the Coachella Valley, that this Gray Fox was caught.

CHAPTER VI

HOW TO KNOW THE DESERTS AND THE DESERT PROBLEMS

LOCATING THE DESERTS

Of the world. It is of interest and a vast assistance to one's geography to swing a globe of the world while the eye follows the horse latitudes, about 30 degrees south latitude and 35 degrees north latitude. Desert names meet the eye frequently at the level of these latitudes. The influence of the great land mass of Asia is emphasized as its deserts move far to the north of the desert zone occupied by the deserts of the remainder of the Northern Hemisphere. The knowledge of geography will be still more advanced if, on an outline map of the world, the deserts are shaded in with pencil or colors and their names given.

Of the Southwest. A map has been prepared for *Deserts* to show the great deserts of the Southwest. Refer to it to locate the regions so frequently mentioned in this book. But there are dry areas and semideserts other than those of the Southwest. If a large map of North America has the southwestern deserts shaded darkly, and the Great Basin, the rain shadows of the Cascades, the sand-hill regions of western Nebraska, western Kansas, western Oklahoma, and western Texas shaded more lightly, then great regions where some desert conditions prevail (such as cactuses on the Nebraska Sand Hills) will be emphasized.

The unsuspected deserts. Any mountain or mountain range of the West casts the rain shadow of a desert over every traveler who moves from west to east. This is marked as one travels over mountain chains, whether they be the comparatively shallow coastal mountains or the great Cascade and Sierra Nevada. A new sensation in travel is afforded him who keeps his eye and mind fixed for the desert of the shadow of the rains.

Every leafless tree in winter proclaims a desert. The woolly gray plants on the brown summer hills of the Far West denote their desert of the summer's dry. The elfin trees of the chaparral are as gnarled and twisted with their slow growth as the trees of the true deserts, for they, too, live in a desert. Sand dunes, with the waters of the ocean just beside them, are deserts. And so are regions of the salt and the salty wet. Investigate these unsuspected deserts to note the plant solutions for their desert problems. One of these will almost always be near at hand.

DESERT FEATURES AND DESERT PROBLEMS IN OUTLINE

A. The true deserts are the results of several agencies.

1. They lie in the descending dry air of the horse latitudes, and mountains on their western borders take most of such moisture as may come with the ocean winds.
    - *a.* Mountains may be snow-capped and forest-covered, but the desert below is dry, with scattered shrubs and dwarf trees as shown in Illustrations 7, 8, 9, and 11.
    - *b.* Cloudbursts in the desert mountains gouge deep ravines into the slopes which have no protection of grass or trees and roll giant boulders onto the desert floor as shown in Illustrations 12 and 13.
    - *c.* Beautiful and fantastic clouds form over the desert mountains, but they bring little or no rain to the desert. See Illustrations 1 and 11.
2. Air, dropping down from the desert mountains, becomes heated through loss of its water and by compression; the lower the air descends the hotter it becomes.
    - *a.* Much of the Mohave is high, from two to five thousand feet, and therefore cooler than the Colorado Desert or Death Valley. See Illustrations 2 and 7.
    - *b.* The Colorado Desert is warmer mainly because it is lower, much of it at or below the level of the sea. See Illustrations 9 and 10.
    - *c.* Death Valley becomes the world's hottest place in summer because most of it is below the level of the sea and because of the high Panamint Mountains on its western border. See Illustrations 1 and 13.
3. Wind is an important agent in making the desert. Wind is caused by the presence of cool or cold regions near regions that are hot; air tends to equalize differences in weight brought about by differences in temperatures.
    - *a.* Wind blows with violence from the cool Pacific through the San Gorgonio Pass into the heated Coachella Valley. This story accompanies Illustration 8.
    - *b.* The Mohave can be much colder in winter and spring than the fruit regions of southwestern California. The cold and dry air of the Mohave then soughs through the passes to underrun this warmer air. This dry air becomes heated as it descends and so forms the dreaded, drying Santa Anas of the region of the oranges.
    - *c.* The cold air of the Tehachapi underruns the heated air of the Mohave to give a fierce and cold wind that blows from noon until midnight on this desert's western fringe.
    - *d.* Wind blows from the cool San Gabriel Mountains into the heated Mohave Desert. See Illustration 7.
    - *e.* Wind makes sand dunes and desert pavement as shown in Illustrations 1 and 14.

B. The unsuspected deserts are made in several ways.

1. All Western mountains cast a rain shadow on their eastern fringe, and even those mountains north of the desert zone have rain shadow deserts that extend away from their eastern bases.
    - *a.* The rain shadow of the Sierra Nevada Mountains makes all of the Great Basin a desert, and the desert conditions have dried old Lake Bonneville down to the present Great Salt Lake and have left on its western margin the Great Salt Desert as in Illustration 5.
2. Cold winter weather brings the conditions of a desert, as proved by annual herbs which die, or deciduous herbs,

shrubs, or trees which shed their leaves as in Illustration 3.

3. The long dry summers of the Far West bring summer-dry desert conditions as shown by the chaparral and summer-blooming plants of the foothills.
4. Sand dunes, even those beside the oceans or the Great Lakes, present a desert that their plant life proves, as shown in Illustrations 4 and 21.
5. Regions of much salt, whether dry or wet, give desert conditions to their plant life, and the plant life shows it. For a dry salt desert see Illustration 5, and for a plant in a wet salt desert see Illustration 6.

C. Desert plants have several methods to solve their water problem.

1. Annual herbs, those succulent plants without woody stems, live in the sands as seeds until enough rain falls to make the seeds grow.
    - *a.* When rains fall in sufficient amounts, the whole desert may become a sea of blossom as in Illustration 15.
    - *b.* Since they must make the most of the short time and the small amount of water, these plants may produce no stems, as shown by Desert Evening Primrose of Illustration 16.
    - *c.* The annual herbs that bloom in the late spring show xerophilous condition of woolly covering and spines as shown by the Prickly Poppy of Illustration 17.
    - *d.* Several years may pass before some annual herbs reappear at all, as described in the story for Squaw Cabbage of Illustration 19.
    - *e.* The Desert Verbena of Illustration 18 faces the stern heat and drought of a true desert by being an annual herb, but the Yellow Sand Verbena of Illustration 4 lives in the mild desert of the ocean's dunes and is a perennial evergreen herb.
2. Perennial herbs, those succulent or non-woody plants that live for more than one season, meet the desert problems in several interesting ways.
    - *a.* Many perennial herbs that live in regions of winter-cold deserts or in true deserts are deciduous perennials. These lose their leaves and stems and live through the desert conditions as rootstocks or bulbs, as does the Desert Lily of Illustration 20.
    - *b.* Some perennial herbs are evergreen and keep living tops aboveground for some years.
        - (1) Evergreen perennial herbs with leaves are not common in desert regions, but a few do occur in the mild desert of the ocean's dunes. One of these, with water stored in thick, viscid leaves, is the Yellow Sand Verbena of Illustration 4. Another, that stores water in three-sided tanklike leaves, is the Sea Fig of Illustration 21.
        - (2) Most perennial evergreen herbs of the deserts have no leaves, but use thick stems to carry green coloring for food making and for water storage. This is true of the cactuses shown in Illustrations 22, 23, and 24. Or they may have leaves reduced to scales and also store water in stems as does Pickle-weed of Illustration 6.
3. Desert shrubs and trees, the woody perennial plants, must meet the water

problem of the desert with methods different from those of herbs.

- *a*. They may be deciduous shrubs or trees, having leaves for a short season only after winter rains. These leaves may be brightly green and fairly thin, but are quickly lost to guard against their water evaporation as the hotter and drier season comes on. Such is true of Ocotillo of Illustration 25; of Smoke Tree, Illustration 33; of Palo Verde, Illustration 34; of the mesquites as shown by the Honey Mesquite of Illustration 58; and of Cat's-claw of Illustration 37.
- *b*. If they are evergreen shrubs or trees, the leaves will have any of several characteristics to resist drying.
  - (1) The leaves may be coated by a layer of gum or resin as are the leaves of Creosote Bush of Illustrations 1 and 28.
  - (2) The leaves may be farinose with a covering of fine gray meal, as in Encelia of Illustration 26, or Desert Holly of Illustration 27.
  - (3) The leaves may be especially thick and tough as those of the yuccas of Illustrations 7, 8, and 29; or Desert Willow, Illustration 30; or Desert Ironwood, Illustration 32; or Washington Fan Palm, Illustration 35.
- *c*. The shrubs or trees may have an extensive root system such as Encelia of Illustration 26, and Creosote Bush of Illustration 28.
- *d*. They may live in arroyos and send long taproots to water as do the Desert Willow of Illustration 30, Desert Ironwood of Illustration 32, Smoke Tree of Illustration 33, Palo Verde of Illustration 34, the mesquites, such as the Honey Mesquite of Illustration 58, and Cat's-claw of Illustration 37.
- *e*. They may be able to live only in oases, as does the Washington Fan Palm of Illustration 35.
- *f*. They may have green coloring matter in the stems to supplement the small and transitory leaves, as does Palo Verde of Illustration 34.
- *g*. Water storage may be in a large root crown as in Ocotillo of Illustration 25.
- *h*. They may be supplied with a great deal of desert plant hardihood that makes it possible for them to survive for many years without any water, as can Creosote Bush of Illustration 28.

D. There are many animals in the deserts and, as with the plants, water is their greatest problem.

1. Most desert animals depend directly or indirectly for water on the desert plants; they secure water by eating plants directly, or they eat other animals, that have eaten other animals, that have eaten still other animals, that have eaten plants.
   - *a*. Desert animals may secure water directly from plants.
     - (1) If they eat dry plant materials, such as do the Powder Post Beetles of Illustrations 41 and 42, they use the water of metabolism that results from the burning of the materials in the tissues of their bodies.
     - (2) Other animals, such as the Big Desert Kangaroo Rat of Illustration 61 and the

Desert Antelope Ground Squirrel of Illustration 63, use the water of metabolism extensively, but may supplement it by gnawing into the pulpy stems of cactuses.

(3) Many desert animals secure water by eating moist plant structures such as leaves and blossoms. This is true of most insects, and of the Crested Lizard of Illustration 47, the Chuckwalla of Illustrations 50 and 51, and the Desert Tortoise of Illustration 56.

(4) The Desert Tortoise, Illustration 56, stores its excess water in two tanks on the inner surface of its shell.

b. Many desert animals secure their water by eating other animals.

(1) This is true of the Centipede of Illustration 39 and of the Scorpion of Illustration 40, which eat insects and other small animals.

(2) Many of the lizards eat insects. This is true of the Brown-shouldered Lizard, Illustration 44; Desert Night Lizard, Illustration 45; Gridiron-tailed Lizard, Illustration 46; Ocellated Sand Lizard, Illustration 48; and Desert Scaly Lizard, Illustration 49.

(3) All the snakes secure their water by eating other animals, such as lizards, mammals, and birds.

(4) All the birds discussed in *Deserts* secure their water from the insects they catch.

2. A few desert animals, such as desert quail, doves, and the Gray Fox of Illustration 64, do not depend directly or indirectly upon plants for water and so must visit water holes.

3. Frogs and toads in the desert, such as the Desert Tree Toad of Illustration 43, eat insects, but are never far from water, as is true of frogs and toads everywhere.

E. Plants and animals in the desert have many features of interest in addition to their handling of the water problem.

1. Desert plants protect themselves by being the world's most thorny objects. Consider the cactuses of Illustrations 22, 23, and 24; the Ocotillo of Illustration 25; the Honey Mesquite of Illustration 58; and the Cat's-claw of Illustration 37.

2. Desert Indians used the desert plants.

a. The beans of the several members of the Pea Family, such as those of the mesquites of Illustration 36, served as food, as did the dates from the Washington Fan Palm of Illustration 35.

b. The leaves from the Washington Fan Palm were used for the thatching of huts.

3. When desert plants are placed in family groupings, one is amazed, among other things, to note the large number of members of the Pea Family: mesquites, Desert Ironwood, Smoke Tree, Palo Verde, and Cat's-claw, for instance.

4. Several of the plants of the desert may be called trees, because of their single central stems and size, which is comparatively large: Joshua Tree, Desert Juniper, Desert Willow, Desert Ironwood, Smoke Tree, Palo Verde, Washington Fan Palm, and the mesquites when well watered as the Honey Mesquite of Illustration 58. These even occur at times in open "forests."

5. The methods used by desert animals in protecting themselves are striking.

a. Many have remarkable protective coloration, such as the Desert Tree

Toad when sitting on its usual granite boulder as shown in Illustration 43; the Gridiron-tailed Lizard of Illustration 46; the Crested Lizard of Illustration 47; the Ocellated Sand Lizard of Illustration 48; and the Texas Nighthawk of Illustration 57.

b. The speed of many under the hot sun is surprising, especially of the insect-catching lizards, such as the Gridiron-tailed Lizard of Illustration 46, the Red Racer of Illustration 53, and the Desert Antelope Ground Squirrel of Illustration 63.

c. The Chuckwalla swells so large with a breath that it cannot be pulled from its rocky retreat, and can also give a lusty thwack with its big tail, Illustrations 50 and 51.

d. Several, such as centipedes, scorpions, and rattlesnakes, can poison their enemies as well as the animals they are capturing for food.

6. Desert animals build interesting homes.
   a. Note the nest mound of the Mohave Pack Rat of Illustration 62 and read its description.
   b. See the elaborate nests of the Verdin, Cactus Wren, and Plumbeous Gnatcatcher, Illustrations 58, 59, and 60.
7. The Powder Post Beetle, like all beetles, has three important stages in growing up, Illustration 42.
8. The "little shells" of the Coachella Valley prove that part of the Colorado Desert was once a lake, Illustration 38.

And then, someday, you will visit the true deserts. May this book have brightened a bit the eyes of appreciation with which they will be viewed.

FURTHER AIDS IN KNOWING THE DESERT

GENERAL

Chalfant, W. A. *Death Valley, the Facts*. Stanford University, California, Stanford University Press, 1936. 160 pp. Illustrated. (Chapters on all phases of this famous desert.)

Chase, J. Smeaton. *California Desert Trails*. Boston, Houghton Mifflin Company, 1919. 387 pp. Illustrated. (Appendices on desert traveling and desert plants.)

Jaeger, Edmund C. *The California Deserts*. Stanford University, California, Stanford University Press, 1933. 207 pp. Extensively illustrated with line drawings. (Chapters on all phases of the California deserts.)

PLANTS IN THE DESERTS

Armstrong, Margaret. *Fieldbook of Western Wild Flowers*. New York, G. P. Putnam's Sons, 1915. 596 pp. Many line drawings, several colored plates. (Most of the desert wild flowers are treated.)

Jepson, Willis Linn. *Manual of the Flowering Plants of California*. Berkeley, California, Associated Students Store, 1923–35. 1238 pp. (The flowers of California deserts are included. Its terminology and distributional notes were followed in *Deserts*.)

Saunders, Chas. Francis. *With the Flowers and Trees in California*. New York, Robert M. McBride & Company, 1923. 286 pp. Illustrated. (Contains a very interesting chapter on desert trees.)

ANIMALS IN THE DESERTS

Anthony, H. E. *Field Book of North American Mammals*. New York, G. P. Putnam's Sons, 1928. 621 pp. Many line drawings, several colored plates. (A manual that will identify for you all desert mammals.)

Bailey, Florence Merriam. *Birds of New Mexico*. Sante Fe, The New Mexico Department of Game and Fish, 1928. 807 pp. Many colored plates. (The finest bird publication from a region where deserts are extensive.)

Hoffman, Ralph. *Birds of the Pacific States*. Boston, Houghton Mifflin Company, 1927. 353 pp. 10 full color plates and over 200 line drawings by Allan Brooks. (Our best field book for birds of the deserts of the Southwest.)

Jaeger, Edmund C. *Denizens of the Desert*. Boston, Houghton Mifflin Company, 1922. 299 pp. Illustrated. (One of the few really good books pertaining to desert animals.)

Nelson, E. W. *Wild Animals of North America*. Washington, D.C., National Geographic Society, 1930. 227 pp. Many beautiful colored plates. (Many desert mammals are pictured and described.)

Patch, Edith M., and Fenton, Carroll Lane. *Desert Neighbors*. New York City, The Macmillan Company, 1937. 170 pp. Illustrated. (An extremely interesting book for the young students of deserts.)

VanDenburgh, John. "The Reptiles of Western North America." *Occasional Papers of the California Academy of Science*. San Francisco, 1922. 2 vols. 1028 pp. Many plates from photographs. (These books supplied the names for lizards, snakes, and turtles as used in *Deserts*.)

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